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SEMI-DRYLOT COW-CALF OPERATION METHOD AS AN ALTERNATIVE
ENTERPRISE FOR THE ALBERTA WHEAT FARM: A CASE STUDY

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF SCIENCE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY

EDMONTON, ALBERTA

FALL, 1971

ABSTRACT

This dissertation analyzes the production of feeder calves as one possible alternative for Alberta wheat producers, who face chronic grain surplus problems due to quota restrictions. Its relevance is based on the observation that grain surpluses may continue, while at the same time demand for beef and consequently feeder calves will remain strong. Inasmuch as any production adjustments must occur at the farm level through decisions made by individual farm operators, the research lies in the field of farm management.

The general approach used in this study was the case study method. An actual 1100 acre farm, typical for Census Division 5, the largest wheat producing region in Alberta, was selected for detailed study. It was hypothesized that under certain conditions a semi-drylot cow-calf operation, utilizing various forms of feed grain and grain by-products from surplus cash grain acres could be profitable, perhaps even more profitable than other alternatives such as oil seed or hog production. It was assumed that the typical farmer wishes to disrupt his usual cropping practices and machinery complement as little as possible. Thus perennial tame hay and pasture requiring special equipment were not considered, as diseconomics in machine use would likely result. On the other hand, it was assumed that most farmers have under-utilized resources such as wild pasture, coulees and sloughs as well as off season labor which could be used in a supplementary way to support a cow-calf operation.

The linear programming method was used to calculate the least cost feed ration for the maximum number of animals, respecting the rules for the necessary levels of nutrients, and other logical relationships. Of the 500

crop acres, 237 were calculated to be in excess of quota requirements and thus available for feed production. Two linear programs were run. Program I considered the possibility of purchasing a limited amount of straw from neighbors. Program II excludes this alternative. The results indicated that 137 cows and their replacements could be kept under the conditions of Program I, and 113 cows under Program II. Under Program I, all of the 237 acres should be seeded to oats; under Program II, 225 acres to oats and 12 acres to barley would be optimal. The other sources of non-supplemental feed, such as straw and chaff, must be fully utilized.

Using the principal analytical tool of this study, namely partial budgeting, it was shown that the farmer could increase his net annual income by approximately 2,000 dollars (about twenty per cent of his present net income) under Program I, or by approximately 1,200 dollars under Program II. The results were based on a five-year average for yields and prices. Inasmuch as these vary considerably from year to year, a break even analysis was compiled, using the principal components. Adoption of the cow-calf program will depend on the attractiveness of other alternatives such as oil seed and hog production. However, it was suggested that other intangible factors such as income stability and insurance value of the cow-calf semi-drylot operation, requiring minimal outlay in additional capital for fixed facilities and equipment, should not be overlooked.

ACKNOWLEDGEMENTS

I would like to express my thanks to the many people who assisted me in creating the final form of this thesis. My special gratitude is extended to Dr. T.A. Petersen for his careful supervision, to Mrs. K. Hohn and Mr. H. Fazel for their literary criticism, to Mr. G.J. Teply for his help with the figures, and to my wife, Jirina, for her encouragement and patience.

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PART I

CHAPTER 1

INTRODUCTION

1.1 The Two Important Problems Dealt with in This Study

At the present time in Canadian agriculture, including the agriculture of Alberta, two important features among several can be observed. These are frequently referred to as the wheat or grain surplus problem and the beef shortages problem. The wheat problem is mainly associated with Western Canadian agriculture. The predominance of grain production on the Canadian Prairies is the result of natural and geographical conditions. Increased demand for beef on the one hand and low supply of cattle on the other is, however, a problem for the whole country. A rapid increase in the consumer's preference for beef, supported by increases in personal income, and the relatively slow adjustment of agriculture to this trend have resulted in a supply gap which can be called the beef problem. The illustration of both problems follows.

1.1.1 The Wheat Problem

In Canadian national, as well as in international dimensions, the wheat problem has been characterized by the existence of large surpluses. Depicting the domestic surplus situation, G.R. Winter has pointed out:

In order to consume the approximately one billion bushels we have in storage, which apparently cannot be sold abroad, it would require that Canadians, every man, woman, child and infant consume one loaf of bread per day for a full eight years. This would only rid us of our current surplus [Winter, 1969, p. 1].

On the world scene a rapid increase in wheat production has occurred, not only in the traditionally major producing countries, such as Canada, the United States, and Australia, but also in countries that were

formerly wheat importers, such as the Soviet Union and Red China. The recent trend in world wheat production is illustrated in Table 1.1.

Although the absolute amount of Canadian wheat production has been increasing, Canada's percentage share of total world production has declined, thus indicating a greater world production and an increased possibility of surplus carry-over if export markets stagnate.¹ According to Madill, the world carry-over situation is such that stocks in the 1968/69 marketing year were about two billion bushels for the five major exporting countries. The wheat stock situation for these countries over a number of years is illustrated in Table 1.2.

From the computed column of the Canadian percentage share of world wheat stocks, one can see that since the latter half of the 1960's approximately one-third of world stocks belongs to Canada. This proportion has been increasing in recent years, with poor prospects for any large-scale absorption of the surplus by the expansion of either export or food aid programs.

The wheat issue is very relevant to Alberta, one of the major wheat producing areas in Canada. The numerical shares for Alberta wheat production are given in Table 1.3. Other grains face problems similar to those of wheat because of their competitive nature either in production or in marketing.

1.1.2 The Beef Problem

The issue of beef can be observed in a domestic context. Canada is

¹J.W. Madill has noted that the Soviet Union imported 295 million bushels of wheat from Western countries in 1965/66, but only 5 million bushels in 1968/69 [Madill, 1969, p.4].

Table 1.1
WHEAT PRODUCTION IN SELECTED COUNTRIES
(1,000 metric tons)

Country	Annual Average 1948-1952	1962	1966	1969 ¹
Canada	13,443	15,392	22,516	18,638
USA	31,065	29,718	35,699	39,634
Australia	5,161	8,353	12,699	12,655
France	7,791	14,054	11,297	14,182
USSR	35,759	70,778	100,499	—
World total	170,857	258,380	308,178	321,262
Canada's percent of total world production	7.85	5.95	7.31	5.80

¹1969 preliminary figures.

Sources: FAO, Production Yearbook, 1967 (Rome: Food and Agriculture Organization of the United Nations, 1968); Monthly Bulletin and Statistics, various issues.

Table 1.2

WHEAT: ESTIMATED JULY 1 STOCKS IN FIVE MAJOR EXPORTING COUNTRIES,

AVERAGES 1940-59, ANNUAL 1966-69

Year	United States grain ¹	Canadian grain ²	Argentina	Australia	France	Total	Canadian as Percentage of Total
			(Million Bushels)				
1940-44	446	463	224	142	3	1,275	36.31
1945-49	193	155	134	75	3	557	27.80
1950-54	524	345	107	110	3	1,086	31.77
1955-59	1,031	653	158	133	63	2,038	32.04
1955	1,036	570	165	160	74	2,005	28.43
1956	1,033	620	130	183	57	2,023	30.65
1957	909	770	160	115	57	2,011	38.29
1958	881	685	175	70	65	1,876	36.51
1959	1,295	620	160	135	59	2,269	27.32
1960	1,314	630	140	145	68	2,297	27.42
1961	1,411	645	100	150	86	2,392	26.96
1962	1,322	425	70	98	62	1,977	21.49
1963	1,195	520	95	155	119	2,084	24.95
1964	901	535	175	117	83	1,811	29.54
1965	817	547	264	163	73	1,864	29.34
1966	535	499	107	120	98	1,359	36.72
1967	425	627	58	244	63	1,417	44.29
1968	539	721	147	158	89	1,654	43.59
1969 ⁴	818	890	102	413	78	2,301	38.68

¹Includes United States wheat in Canada.²Includes Canadian wheat in United States.³Prior to 1955/56, July 1 stocks not available.⁴Preliminary.Source: U.S.D.A., Wheat Situation (Washington, D.C.: Economic Research Service, U.S.D.A., November 1969), p.38.

Table 1.3

POSITION OF ALBERTA IN WHEAT PRODUCTION

Year	Canada	Prairies	Alberta		
	'000,000 bu	'000,000 bu	'000,000 bu	% of Canada	% Prairies
<u>Production</u>					
Average 1955-59 ¹	465.6	444.0	116.2	25.0	26.2
1960	518.4	498.0	100.0	19.3	20.1
1961	283.4	260.0	89.0	31.4	34.0
1962	565.5	546.0	112.0	19.8	20.5
1963	723.4	703.0	149.0	20.5	21.2
1964	600.4	578.0	145.0	24.1	25.1
1965	649.4	632.0	153.0	23.6	24.2
1966	827.3	807.0	191.0	23.1	23.7
1967	592.9	574.0	145.0	24.5	25.3
1968	--	--	--	--	--
1969	--	--	--	--	--
<u>Carry-over on farm at July 31</u>					
Average 1955-59 ¹	163.4	155.7	37.9	23.2	24.3
1960	--	--	--	--	--
1961	--	--	--	--	--
1962	59.2	56	15.0	25.3	26.8
1963	64.7	63	12.0	18.6	19.0
1964	120.6	118	20.0	16.6	16.9
1965	109.1	107	21.0	19.2	19.6
1966	100.0	98	23.0	23.0	23.5
1967	205.0	202	40.0	19.5	19.8
1968	236.0	--	52.0	22.0	--
1969	372.0	--	85.0	22.8	--

¹1955-64 for carry-over.

Sources: Alberta Department of Agriculture, Agricultural Statistics for Alberta (Edmonton: Economics Division, ADA, various years); Dominion Bureau of Statistics, Canada Year Book (Ottawa: Queen's Printer, various years).

not among the principal world beef exporting or importing countries.¹ Hence, the domestic demand for beef is a decisive factor for the Canadian beef industry. Yankowsky has presented a comprehensive paper on Canadian demand and consumption of beef with historical trends and predictions for the future [Yankowsky, 1970]. Looking at the whole postwar period, Yankowsky remarks that "... notwithstanding the rising beef prices, per capita consumption increased significantly. A possible explanation is that no major food product enjoys a consumer preference as strong as that for beef ..." [Yankowsky, 1970, p.56]. Per capita consumption of beef in 1980 will, according to Yankowsky, be roughly 106-117 pounds. Total consumption will be 2.7-2.9 billion pounds. According to another prediction, per capita beef consumption in 1980 will reach 122 pounds [Rosario, 1971]. To satisfy such a demand, the number of cattle, excluding calves and dairy cows, on farms at June 1, 1980 should be approximately, according to Yankowsky, ten million head compared to the average of 6.5 million for 1967-69.

1.2 Objectives and Hypotheses

Observing the effect of the grain problem on the everyday life of a central Alberta farmer, it is possible to see that farmers in the grain producing areas will face a limited market for grain for many years to come.² Such a situation implies poor utilization of resources and a high degree of uncertainty about the future. That is why farmers look for alternative enterprises. The most suitable alternative enterprise

¹Canada's beef exports and imports are slightly over one percent of the world total.

²Although there are both pessimistic and optimistic views among economists.

would be one that utilizes mainly those resources which are either partly idle (seasonal labor or machinery) or involved in the production of non-salable grain. Three common alternatives to alleviate grain surpluses are: production of oil seeds (flaxseed, rapeseed); hog production; and beef production. The last alternative will be examined in this study.

As shown above, the long-term outlook for beef is favorable, but the question arises as to whether Western Canada can produce enough beef calves to meet feedlot requirements. This study hypothesizes that a semi-drylot operation is a feasible method for helping to solve the national problem of beef calf production, as well as giving more flexibility to the existing grain producer. The purpose of this research project is to explore the feasibility of a semi-drylot method of cow-calf production using resources which are now tied up in grain production.

Farm production studies traditionally regard overall profit maximization as the farmer's principal objective. A grain producer, however, wishes to sell as much grain as he can. Hence, secondarily, he is looking for a practical alternative to utilize his idle and noneffectively employed grain producing resources. For practical purposes the current study adopts the latter, rather than the more theoretically oriented, former point of view.

1.3 Scope and Plan of Study

In order to meet research objectives, the case study approach has been chosen. It is believed that selecting a typical farm will inspire more confidence on the part of the producer, for whom this work is primarily designed.

Census Division 5 is one of the most important grain producing areas

in Alberta. For that reason the case study farm was so selected as to be typical for this division. The following methodological framework is employed in examining the effect of the semi-drylot cow-calf enterprise as a viable alternative for the grain producers.

From the total cultivated farmland, the number of acres sufficient to provide grain for quotas is delineated. For the remaining acreage, the least-cost feed combination is calculated for the maximum size of cow-calf operation, assuming that the side products of grain will be used for feed. The effect of the new enterprise on net farm income is then examined.

The whole study breaks down into two parts. Part I deals with the theoretical problems; Part II examines the particulars. In Chapter Two the relevant economic theory is explained. A theoretical background of the main tools used is the subject of Chapter Three. Chapter Four, the first chapter in Part II, describes the area of observation, Census Division 5, and the case study farm. Chapter Five presents the relevant analyses, including data collection. The last chapter transforms results into conclusions, gives recommendations, and suggests some topics for further research.

CHAPTER 2

THE ECONOMIC THEORY

The economic theory of production under conditions of perfect competition is relevant for the problem under study.¹ Although the conditions of perfect competition are not completely satisfied in practice, a single farm approximates a perfectly competitive firm in both the factor and product markets. The main propositions of economic production theory are summarized in the next section; no attempt is made to alter the standard approach of production theory [Heady, 1964; Lancaster, 1969].

2.1 Principles of Production Economics

Production economics applies economic principles to the study of production. Production involves the transformation of a commodity, or commodities, into another, different commodity or commodities. Different factors or inputs enter a production process in the beginning, and product or output leaves the production process at the end. Hence, production economics deals with the following five basic principles:

- 1) Determination of an optimal point of production; that is, determination of quantity of resources used and goods produced such that profit is maximized.
- 2) Determination of the least-cost combination of substitutable factors for a given level of output.
- 3) Determination of an optimal combination of products which can be produced by a given kind and quantity of factors.

¹Perfect competition is characterized by a large number of firms in the industry, by a negligible influence on industry prices by the activities of any individual firm, by identical product and uniform technology, and by unrestricted entry for any new firm.

- 4) Problem of choice of one among a number of alternatives of resource utilization.

- 5) Problem of resource allocation over periods of time.

The above principles are, of course, interconnected, and in practice more than one principle is usually involved at any given time. An explanation of the principles follows.

2.1.1 The Input-Output Model

The input-output model is concerned with the relationship between a quantity of inputs and the resulting output. The basic physical relationship between inputs and output in the production process is called a production function, which is generally written as:

$$Y = f(X_1, \dots, X_n). \quad (1)$$

This equation says that output Y depends on a number of inputs X_1 to X_n . Figure 2.1 (its upper half) depicts the classical shape of a production function in the case of one variable input and one output.

The quantity of output which is producible by the given amount of the variable input is called return to scale. When the amount of input changes, the amount of produced output changes also according to technical or biological laws. The nature of such a change can vary. On the classical production function, five types of returns to scale (that is, the changes in output when input is increased by a constant quantity, for example, one unit) can be distinguished; namely:

- 1) Increasing—in the beginning, output rises more than input;
- 2) Constant—output grows less, but the proportion between increase in output and input is the same;
- 3) Diminishing—the speed of output growth lessens to such a degree

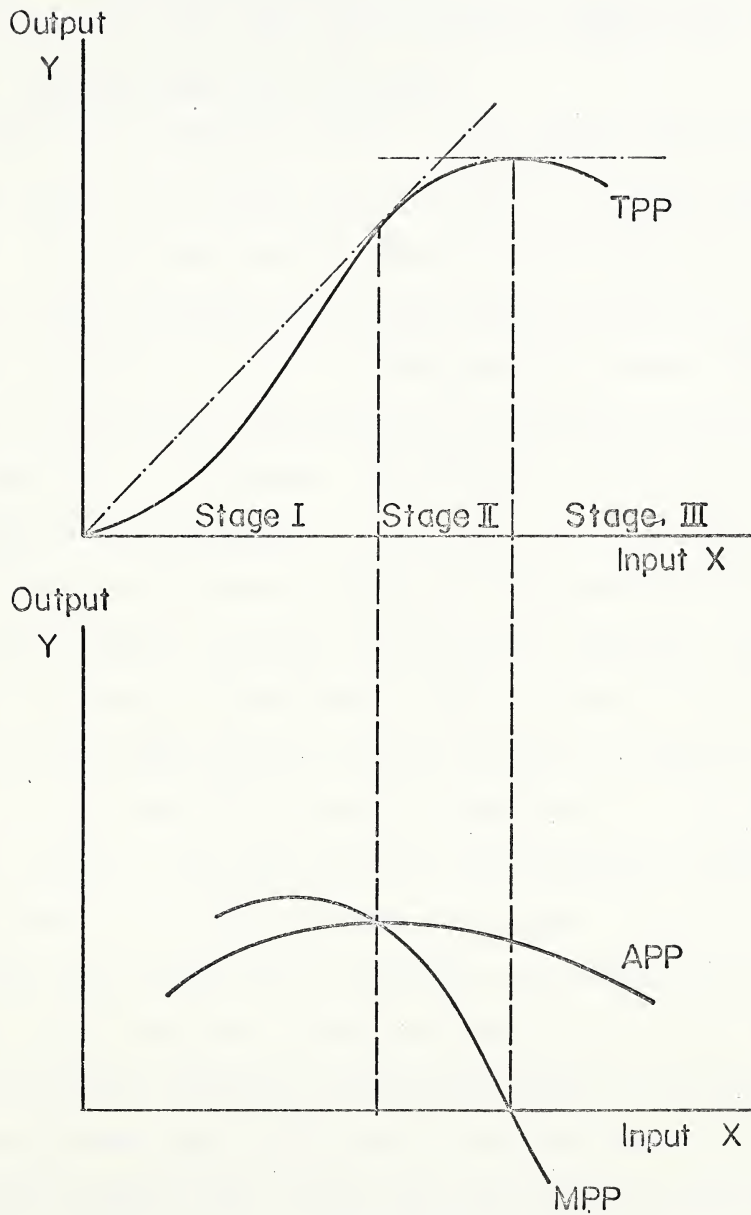


Figure 2.1

CLASSICAL PRODUCTION FUNCTION

that with additional units of input, output still rises, but the additional gain in output is always declining;

- 4) Equal to zero—with the further application of input, no change in output occurs;
- 5) Negative—when more input is applied, output is not only nonincreasing, but it declines.

The change in physical quantity of the output caused by one additional unit of the variable input is called the marginal physical product (MPP). When the total physical quantity of the output, the total physical product (TPP), is divided by the total physical quantity of the variable input, the result is called the average physical product (APP). In Figure 2.1, the TPP is represented by the production function curve in the upper half of the diagram. The MPP curve and the APP curve are depicted in the lower half.

Figure 2.1 also shows a division of the production function curve into three stages. In Stage I the MPP rises, culminates, and then starts to decline. The APP rises. However, because the MPP is here always greater than the APP, it is not rational to operate in Stage I. The point where the MPP is equal to the APP occurs at the boundary between Stages I and II. From this point, the APP decreases, the MPP continues to decrease, and the APP is greater than the MPP. But the MPP is still positive, which means that by adding one unit of input some increase in output is still possible. This is why Stage II is the only relevant one; the variable resource is here best utilized. The right-hand boundary of this stage is the point at which the TPP is at its maximum and MPP is equal to zero. Stage III, which covers the area where the TPP decreases and, therefore, the MPP is negative, is obviously

irrational. A good manager would operate only in Stage II.

Taking the exogenously given factor and product prices into consideration, along with the physical quantities used and produced, one may obtain cost and revenue curves, as shown in Figures 2.2 and 2.3. To explain the significance of these curves, some technical terms must now be clarified. Profit means the difference between total revenue and total cost, where total revenue is the total physical product multiplied by the price of a unit of output, and total cost is the summation of all used resources multiplied by their price. When the total revenue (TR) and the total cost (TC) are divided by the number of units of output, the average revenue (AR) and the average total cost (ATC), respectively, are obtained. The terms marginal revenue (MR) and marginal cost (MC) refer to changes in TR and TC respectively when one additional unit of output is produced. The terms marginal value product (MVP) and marginal factor cost (MFC) describe changes in TR and TC respectively from the addition of one unit of the variable input.

Three important conditions for profit maximization are now noted:

- 1) A positive profit must exist; that is, total revenue must be greater than total cost. In terms of averages, this condition implies that average revenue (which is equivalent to product price) must be greater than average total cost.
- 2) The last unit of output sold must increase revenue by an amount equal to the additional cost of producing that last unit. Technically, this condition requires that the factor/product price ratio must be equal to the marginal physical product.
- 3) At the point of maximization, marginal value product and profit must be decreasing with respect to further application of input.

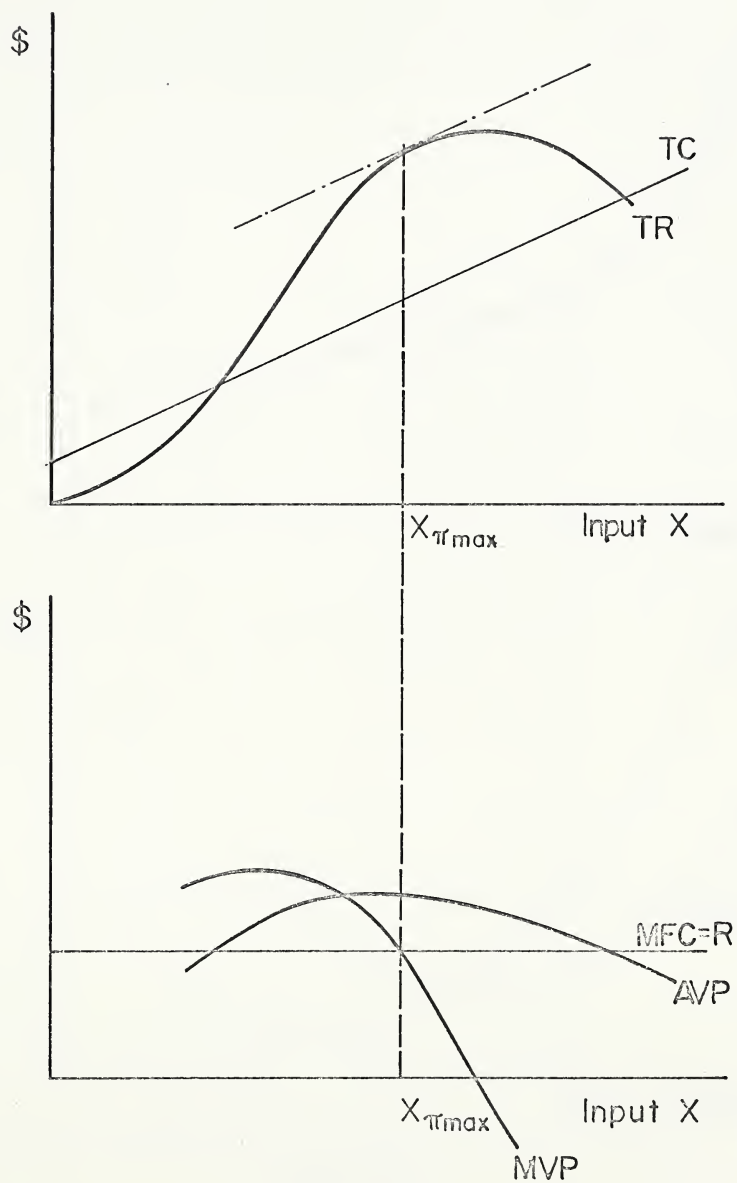


Figure 2.2
 PROFIT MAXIMIZATION
 (Input Approach)

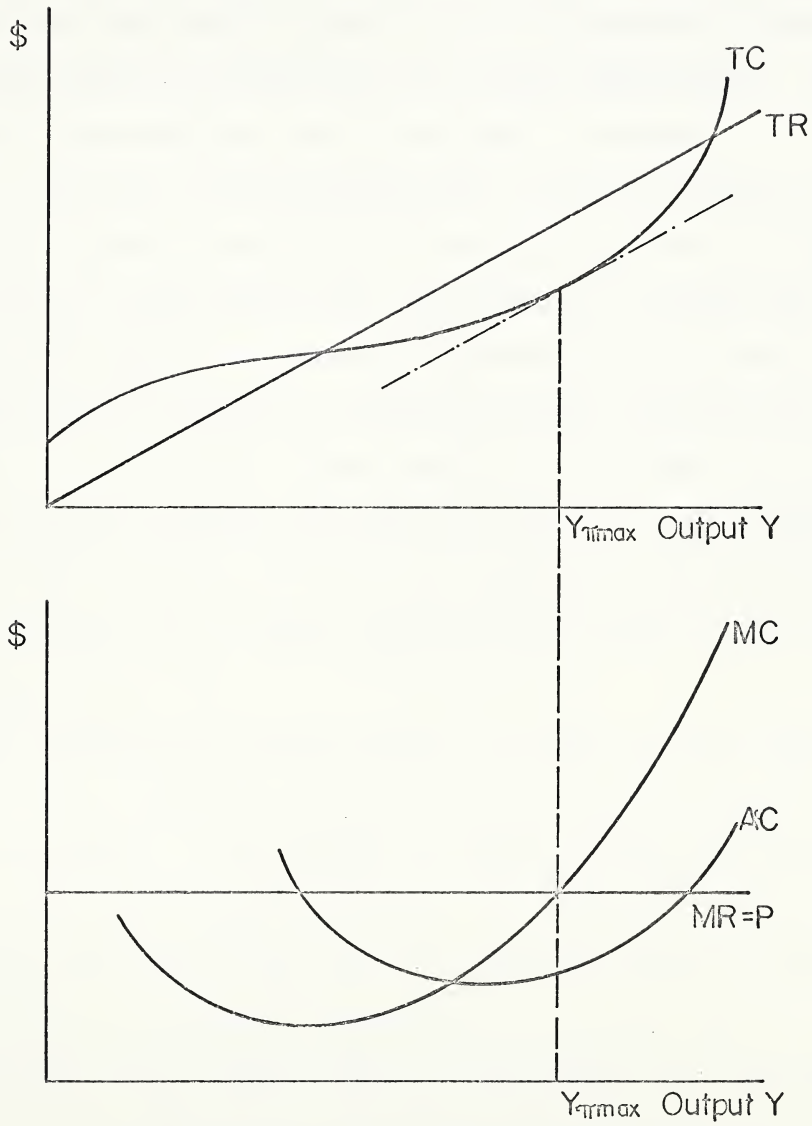


Figure 2.3

PROFIT MAXIMIZATION
(Output Approach)

In terms of calculus this situation is known as the second order condition.

2.1.2 The Input-Input Model

The input-input model is used to analyze the problem of combining two or more available resources that are mutually substitutable. For purposes of explanation the case of two inputs is examined.

Let X and Z be two substitutable inputs required to produce an output Y . If any technically feasible way of producing Y (called a "process"¹) is available, it can be graphically represented by a straight line. Each point on the straight line represents a particular level of output. If only one process is available, no problem of choice among different combinations of inputs arises. If two processes are available, each process is represented by a straight line from the origin, as shown in Figure 2.4. A given level of output, say q , may now be produced either by process P_1 or process P_2 , or by a linear combination of P_1 and P_2 , such as point A in Figure 2.4.

The introduction of a third process, P_3 , which uses more inputs than either P_1 or P_2 to produce q , does not increase feasible choices because P_3 is uneconomical. A line joining all economically feasible points of input combinations is called an isoquant. The isoquant assumes an increasingly smooth shape as the number of available processes is increased. Such isoquants are graphed in Figure 2.5.

Knowledge of the isoquant shape is a necessary but not sufficient condition for deciding on the optimal combination of inputs. Factor price

¹"Process" means a technological method that combines inputs in constant proportion.

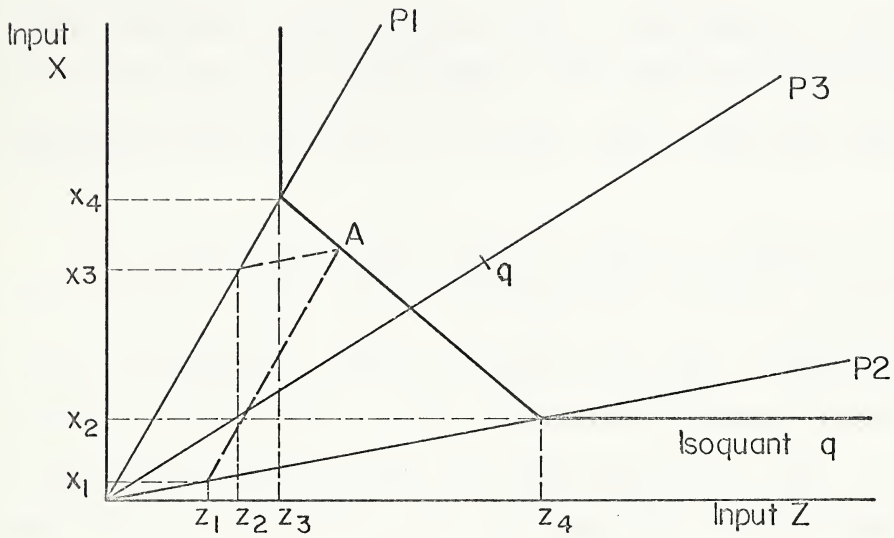


Figure 2.4

THE TWO INPUT MODEL WITH TWO PRODUCTION PROCESSES

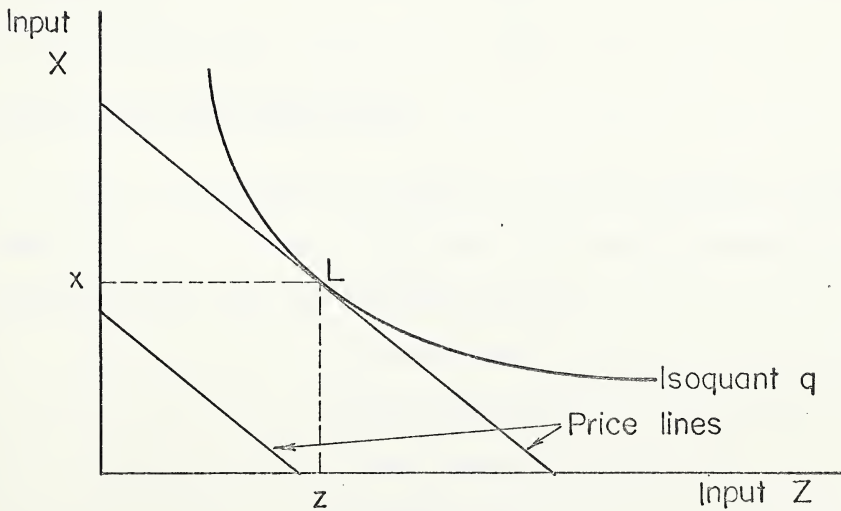


Figure 2.5

THE LEAST COST COMBINATION OF INPUTS

information is also required for such a decision. Given the prices of factors X and Z, one can draw the so-called price ratio line so that its slope is equal to the negative inverse price ratio. The optimal point is then the point at which the price line is just tangent to the isoquant. In economic terms, the optimal point is that point at which the cost of employing an additional unit of X is just equal to the cost reduction in Z.

A distinction may be made between two types of decisions using the above principle. First, given a desired level of output, the optimal point is determined by shifting the price ratio line to the point of tangency as defined above; second, given a fixed budget, the optimal point is the highest isoquant lying on the fixed price ratio line. In this latter case the fixed price ratio line represents the fixed budget available for purchasing inputs; therefore, it is called the budget line.

One may note that when factor and product prices are given to a producer, the least-cost combination of factors is a requirement for profit maximization.

2.1.3 The Output-Output Model

With a fixed amount of inputs it is often possible to produce more than one type of output. The mutual relationships between any two outputs producible with the same resources may be:

- 1) Competitive,
- 2) Complementary,
- 3) Supplementary,
- 4) Joint.

These relationships are depicted in Figure 2.6 with the aid of

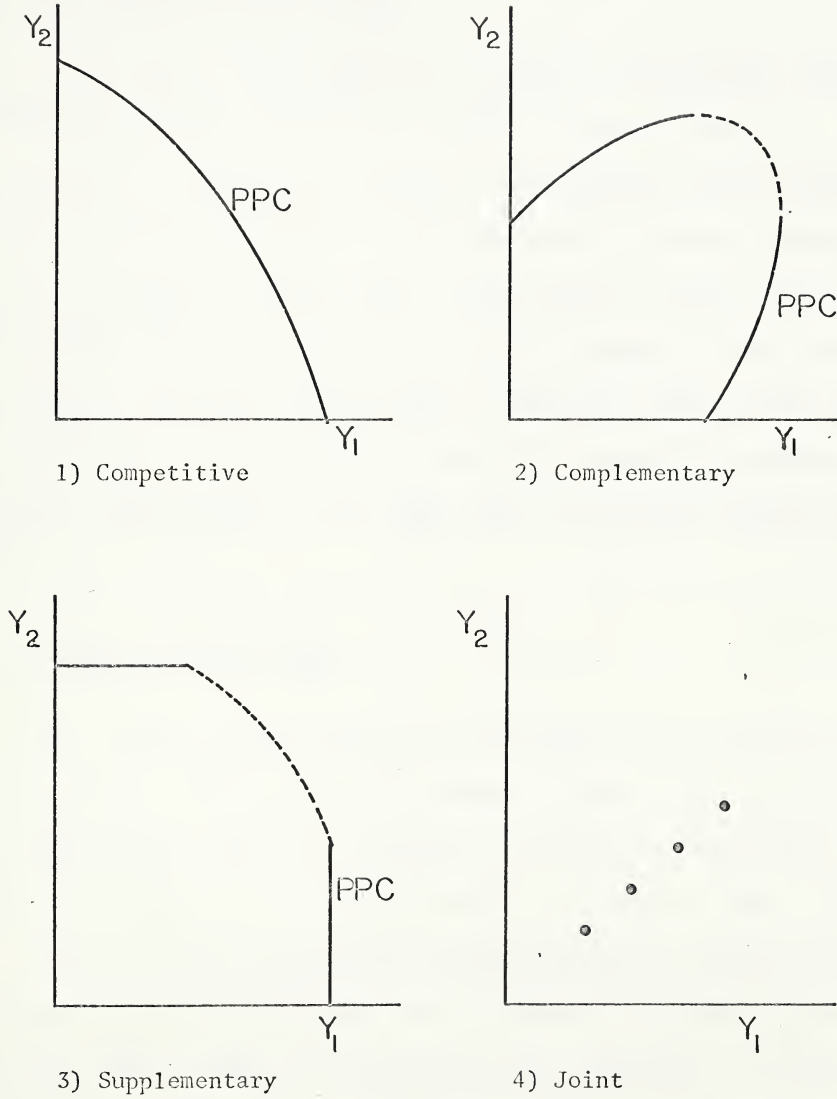


Figure 2.6

THE MUTUAL RELATIONSHIP OF PRODUCTS

production possibility curves (PPC). Complementary, supplementary, and joint products present no basic problems of choice because increasing the production of any product does not necessitate giving up production of the other. A decision making problem arises in the case of competitive products. This problem is resolved by determining an optimal product mix that yields maximum revenue.

In the case of two competitive products, all possible combinations of the two products are given by the PPC¹ shown in Figure 2.7. The slope of the PPC at a given point refers to the marginal rate of transformation of one product into another. Given the product prices, revenue lines may be drawn having the slopes equal to the negative inverse price ratios. The optimal point is given by the point of tangency between the PPC and the highest attainable revenue line. Generally, when a given input is to be allocated into production of a number of competitive outputs, the marginal value product of the input from all produced outputs must be the same.

2.1.4 The Opportunity Cost

The concept of opportunity cost pertains to the problem of the best way to utilize limited resources through a number of known alternatives. The "opportunity cost" of a resource is defined as "the return the resource can earn when put to its best alternative use" [Doll, 1969, p.27].

The alternative yielding the maximum difference between the revenue it creates and its opportunity cost is chosen as the best alternative. In the event that a number of alternatives are undertaken, an optimal decision would be to equalize the marginal returns from all the alternatives. This

¹The PPC is also referred to as the transformation curve in the literature.

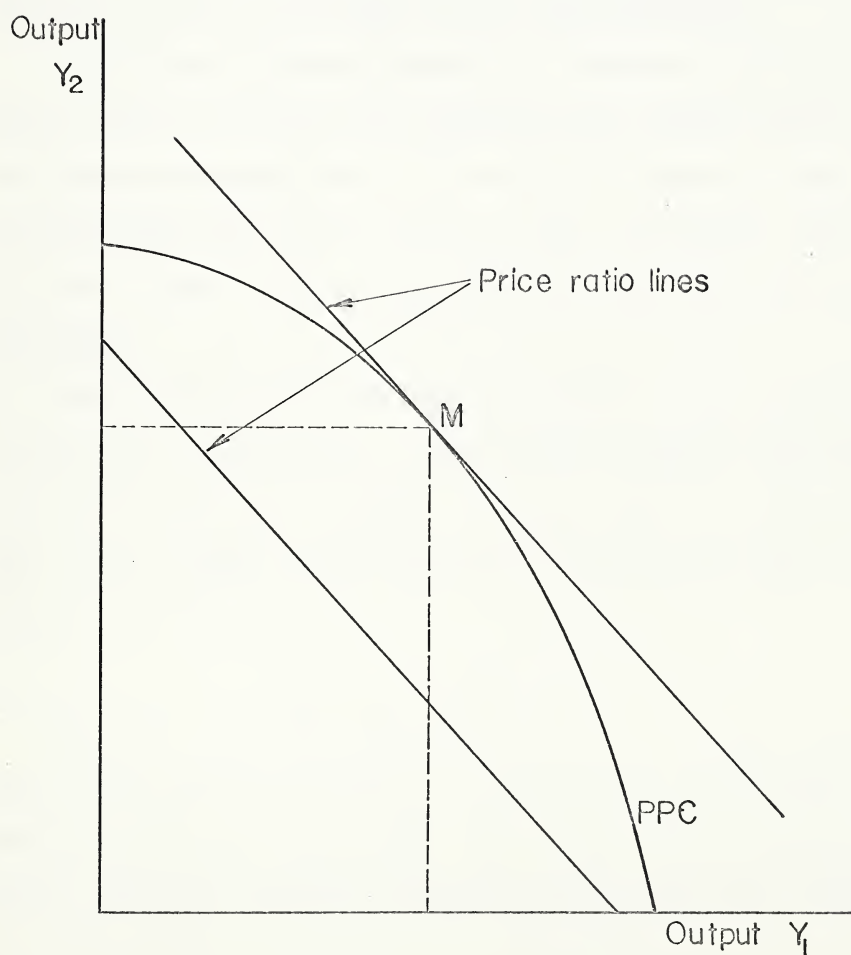


Figure 2.7

THE MAXIMUM REVENUE COMBINATION OF OUTPUTS

is the principle of equimarginal returns.

2.1.5 The Dynamics of Production

To this point the effects of time in the production economics have not been considered. Explicit introduction of time in the discussion is associated with the problem of optimal intertemporal allocation of limited resources, as well as with that of risk and uncertainty.

The problem of optimal allocation of resources over a period of time arises primarily because of the interdependence between resource allocation and production decisions, and outcomes of respective time units. To obtain maximum profit over a period of time, the marginal profit per time unit must be equal to the average profit per time unit, if no time preference exists.

Consideration of time preference in production processes is related to the degree of uncertainty as well as the alternative opportunity cost interest rate faced by a manager. The basic profit maximizing criterion here is that marginal revenue per unit of time must be equal to marginal cost per unit of time.

* * * *

The theoretical principles presented up to this point are applied by using various tools of analysis. The tools used in this study are partial budgeting and linear programming. These tools, their relationship to theory, and their limitations are the subject of the next chapter.

CHAPTER 3

TOOLS OF ANALYSIS AND DATA REQUIRED

The partial budgeting method has been selected as the main analytical tool of this study. This is a powerful instrument with which to examine the effect of the contemplated cow-calf enterprise on the farmer's income. For the tasks of determining the least-cost feed ratio for animals and the maximum number of animals, linear programming has been used. Other statistical tools, such as means or modes, play only a minor role in the analysis.

3.1 Partial Budgeting

Budgeting, in general, is a method which estimates the result of an enterprise or a production process before that enterprise is undertaken. Budgeting summarizes in tabular form all expected costs, revenues, profits, and losses of an enterprise. The most important characteristic of budgeting is its exclusive reference to the future. Because all calculations are appraisals or estimates, all results drawn from the budget must be seen from this perspective. The budgeting method is applied to a given time period, usually one year. It breaks down into several categories, including complete budgeting, cash budgeting, and partial budgeting.

Complete budgeting is generally used when a new farm business is being considered, or if some basic condition of an already operating farm changes in such a way that it affects all major aspects of the farm business. All anticipated expenses and incomes are summarized for the farm for one year under a specific type of plan.

Cash budgeting plans all financial events which are associated with a farm. It is generally done on a monthly basis in order to estimate loan requirements.

Partial budgeting involves only a portion of the farm business. It is the most frequently used budgeting method from the point of view of farm management and decision making in an ongoing farm business. Its use is recommended whenever any farm activity changes. It can be used to estimate profit changes when an enterprise is changed in scale, when it is left out, when it is begun as a new enterprise, or when technological changes are expected. The importance of partial budgeting arises from the fact that such changes are frequently made in the day-to-day operation of a farm. Partial budgeting could also be called marginal budgeting because the changes being estimated are often relatively small.

3.1.1 The Partial Budgeting Procedure

The partial budgeting method distinctly analyzes "advantages" and "disadvantages" to be expected by a producer from a proposed change. Advantages include not only increased revenue, but also expected reduced costs. Disadvantages include added costs and reduced revenues.

The general layout of the partial budgeting scheme appears below:

The Partial Budgeting Model

Advantages	Disadvantages
1. Added Revenues	3. Added Costs
2. Reduced Costs	Fixed Costs
Fixed Costs	Variable Costs
Variable Costs	4. Reduced Revenues

Total Advantages - Total Disadvantages = Estimated Change in Net Income

3.1.2 Economic Theory Underlying Partial Budgeting

Unfortunately, there is very little written in the literature on the economic theory underlying partial budgeting. Fellows is particularly noted for his contribution to the topic [Fellows, 1960].

Partial budgeting as a practical farm management tool makes direct use of economic theory in two ways: (1) The partial budgeting method can be used as an analytical instrument for a separate solution of input-output, input-input, or output-output models. This involves one step along either the total revenue curve (analogous to the production function curve when output and input are multiplied by their prices), the isoquant, or the production possibility curve respectively towards the optimal point; (2) When used for a combination of the three economic models, the partial budgeting scheme components are closely connected with the concepts of economic theory. The least-cost combination corresponds to reduced costs and added costs, which leads to a resource combination closer to the optimal point. Similarly, added revenues and reduced revenues correspond to the best choice of outputs, moving closer to the best revenue creating combination of products. When dealing with added costs and added revenues in the partial budget, one can visualize a movement along a production function curve. All curves mentioned are shown in the second chapter. All relationships work together in the partial budget.

The concept of opportunity cost is covered by the reduced revenue component. This problem can be solved either by comparing a number of budgets of several alternatives, which may be laborious, or by simultaneous solution of several partial budgets using the mathematical language of linear programming.

The time factor can be expressed only indirectly in partial budgeting, either through an adjustment of individual items by certain techniques, such as discounting, or by comparative statics, i.e., by comparison of two or more static stages within a given time period.

3.1.3 Advantages and Disadvantages of Partial Budgeting

The following features of partial budgeting work to its advantage:

- 1) Partial budgeting is simple with respect to its structure and, therefore, can be used by the average farmer.
- 2) It does not require complex computational aids, such as electronic computers or other equipment.
- 3) It does not consume too much time. Thus, it is quite flexible and can be used for all types of changes.
- 4) Partial budgeting is able to provide a very clear picture of all aspects of the proposed change as a basis for decision making.
- 5) It requires a priori a comprehensive understanding of the production situation; therefore, its results, if calculated properly, have a high degree of reliability.

One must also recognize the disadvantages of partial budgeting, namely:

- 1) Its simplicity can be a disadvantage for more complicated or specialized analyses because it compares only two alternatives. This disadvantage can sometimes be avoided by considerable experience, which permits one to select the most relevant alternatives.
- 2) Partial budgeting excludes dynamic changes; that is, it does not adequately consider the time dimension.

- 3) Partial budgeting involves estimates. Hence, it has all the defects of estimates; i.e., defects of imperfect knowledge of data, especially exogenous data, such as future market prices of inputs and outputs. Pricing future output is a particularly crucial problem for the farmer.
- 4) It does not compare risks associated with enterprises.

3.1.4 Information Requirements for the Cow-Calf Enterprise

Before starting any work on a budget, one has to be clear about the specific situation so that all possible changes can be considered. For the cow-calf enterprise planned in this study, the following are the major features of the situation.

A typical grain farm that produces three kinds of grain—wheat, barley, and oats—is considered. The market situation for grain is represented by policies of a grain board (such as the Canadian Wheat Board), which permits selling only part of the normal production of grain through regular market channels. The balance of the production can be sold only through "black market channels."¹ It is hypothesized that a positive change of net farm income can be made by reducing cash grain production, salable only at discounted prices, and replacing it with a cow-calf operation.

The method of cow-calf production considered is the semi-drylot. (See Appendix B.) Feed will mainly be produced on the farm, but some limited purchase of feed is possible. The sale of output occurs once a year, following the herd production cycle.

It is assumed that there is a surplus of labor on the farm, except

¹The term "black market channels" does not refer to an illegal activity. Rather it describes marketing on a neighborhood basis, generally at reduced prices.

during the labor intensive peaks of grain production, and that the farmer will have no problem in obtaining credit for investment. Land, then, is the only limited resource. Turning now to the partial budgeting form for the enterprise, the following items should be taken into account.

3.1.4.1 Added Returns

Added returns are represented by returns from the cow-calf operation, and they are created by two items: revenues from selling calves and revenues from culling old cows. To compute these returns, one needs information about prices, weights, and numbers of calves and cows.

Knowledge of prices of both products is crucial for the final result. However, this knowledge is also the hardest to obtain. The usual recommendation is to use an average of the prices in the relevant season (when the sale usually occurs) for at least five years.

The number of calves for sale can be obtained by adjusting the number of cows and pregnant heifers by the calf/crop ratio and subtracting the number of young heifers needed for replacement. This can be done if the size of herd is known in the beginning. If it is not, it is necessary to calculate the fixed pattern of the herd structure on an annual basis for, for instance, one hundred herd management units (where a herd management unit is equivalent to a fertile cow or heifer plus the fixed proportion of other categories). Then the number of herd management units that should be kept on the farm can be calculated.¹ The number of cows and calves for sale can be obtained by multiplying the calculated number of herd management units by the fixed proportion of salable animals from the fixed pattern. Weights have to be estimated on the basis of past experience.

¹Refer to the section on linear programming below.

The number of cull cows may be similarly obtained. The direct method using the rate of culling can be employed if total herd numbers are known beforehand. If not, the indirect method, using a fixed pattern of herd management units, may be used.

3.1.4.2 Reduced Costs

In this section the cost incurred by producing grain that is going to be eliminated is estimated. In this case no reduction in fixed cost will be considered, assuming that grain production remains the primary production of the farm, not only for cash crop, but also for feed grain. The farmer is not going to sell any of his grain machinery or buildings just because he reduces his acreage of cash crops.

Labor is not considered either as an advantage or a disadvantage. During the periods when it will be required by the beef enterprise it will be in surplus, and it will not be changed as far as grain production is concerned. By the planned change in production, no change in the total farmland will be made. Therefore, this item will not appear in any of the partial budget calculations. Thus, only the variable cost of reduced grain production has to be considered; namely, seed, fertilizer, fuel, repairs, and storage facilities. All this information can be gathered from the farmer's past experience.

3.1.4.3 Added Costs

This section will include all cost increases caused by the added cow-calf enterprise. These fall into two main categories, fixed and variable. Introduction of the cow-calf operation will result in some additional fixed costs. Heifer investment can be estimated at the annual rate of interest

from the total purchase value of heifers, assuming that at the end of a planning period the value of the herd will be the same as at the beginning. The cost of a bull could be calculated in the same way, but it seems more practical and logical to consider the cost of insemination under variable cost. This allows the possibility of choice between natural and artificial insemination.

The semi-drylot operation does not generally require any special buildings. Only costs associated with the construction of some fences, water facilities, or other small adjustments to provide adequate space are relevant. For such items both the interest rate and annual depreciation must be taken into account. Machinery is here mentioned only peripherally because little special machinery is needed for the operation. One should count only additional equipment needed, such as a scale or a chaff collector. Calculations will be the same as for the previous items, namely interest and depreciation.

Added variable costs are those which arise mostly from everyday care of the animal. The cost of feed is the most important item in variable costs of cow-calf enterprise. The cost is calculated, of course, from the selected feed ration and the price of feeds. There are several ways to establish the suitable feed ration; for instance, following recommendations from the literature, from neighbors, or from experience. It is felt, however, that the use of nutrient tables and the composition of feed tables for a precise calculation is best.¹ The value of feeds is determined by their variable cost in the case of owned feeds or by their price in the case of purchased feeds.

¹Refer to the section on using linear programming for feed ratio calculation which appears later in this chapter.

Veterinary services can be estimated through detailed analysis or by using an average figure per cow, which usually does not vary much from farm to farm. As mentioned before, there are two alternative insemination methods: to keep a bull or to use artificial insemination. In both cases, the cost will be approximately the same so that one can use a constant rate per cow.

3.1.4.4 Reduced Returns

Under theoretical conditions, there should not be any reduced benefit when diminishing production of grain which is not salable through grain board channels. In practice, however, one has to consider black market channels outside the regular market. These are usually farm-to-farm sales at greatly reduced prices, running at one-half to three-quarters of the official quota price. The reduced benefit is represented by the quantity of grain given up at this nonquota price.

The difference between total advantages and total disadvantages is the expected net income change to the farm from adding a cow-calf enterprise. The farmer's decision will depend on whether the expected net income change is positive or negative, as well as on other personal considerations, such as the extra work involved or risk incurred.

3.2 The Linear Programming Method

In this study linear programming has been used to determine the least-cost feed ration. This is one of the two important applications of linear programming. The other is the determination of the maximum size of planned herd possible with respect to the given source of feed.

3.2.1 The Principle of Linear Programming

In general, linear programming is a mathematical method for optimizing (i.e., maximizing or minimizing) a given objective subject to a set of constraints. The given objective is specified to be dependent on a linear combination of a number of variables, called processes. Such a specification is termed the objective function. Given the objective function and the set of constraints, one can determine that combination of processes, and their levels, which will optimize the objective function.

Using mathematical symbols, a linear programming problem can be written as:

$$\begin{array}{ll}
 \text{Max (Min) } Z = c_1x_1 + c_2x_2 + \dots + c_nx_n & \left. \vphantom{\begin{array}{l} \text{Max (Min) } Z = c_1x_1 + c_2x_2 + \dots + c_nx_n \\ \text{Subject to:} \\ a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n \leq b_1 \\ a_{21}x_1 + a_{22}x_2 + \dots + a_{2n}x_n \leq b_2 \\ \text{-----} \\ a_{m1}x_1 + a_{m2}x_2 + \dots + a_{mn}x_n \leq b_m \\ x_1 \geq 0; \quad x_2 \geq 0; \quad \dots \quad x_n \geq 0 \end{array}} \right\} \begin{array}{l} \text{objective function} \\ \\ \\ \text{capacity or technical} \\ \text{constraints} \\ \\ \text{non-negativity} \\ \text{constraints} \end{array}
 \end{array}$$

Where:

$Z \equiv$ target

$c_j \equiv$ prices

$x_j \equiv$ processes

$a_{ij} \equiv$ technical coefficients

$b_i \equiv$ constraints

(2)

Several methods of solving a linear programming problem are available, the most commonly used being the simplex method. In the case of large problems,

computerized solution programs are used. Therefore, a detailed knowledge of the simplex method is not essential.¹

As an analytical device, linear programming can consider many variables and thus can solve very complex problems. It is a precise and reliable tool for decision making, providing the information used is accurate. A distinct limitation of linear programming is the underlying linearity assumption, which, in the case of a production process, implies constant returns to scale that may not reflect reality.

3.2.2 The Linear Programming Method Used for the Least-Cost Feed Ration Calculation for Cow-Calf Operation

Delineating a linear programming problem requires the same clarity of thinking as the partial budget. Failing to realize some secondary relationships or to consider some apparently obvious facts may cause nonsensical results, even though a sophisticated mathematical technique is used.

The situation in this study is as follows. A farmer has reserved a certain part of his total acreage for growing feed crops for cow-calf production. He decides on the types of crops to grow for feeding purposes (wheat, barley, oats). Different components of the same crop can be used (grain, straw, chaff), and the same crop can be harvested in different stages (mature or greenfeed). There are also certain limited amounts of side products from cash crop production suitable for use as feed, such as straw and chaff. Finally, it is possible to buy some feed from a neighbor, although such a source may be limited.

There are two goals: to minimize the cost of the feed ration and to

¹There are various sources of computing services either through public or private sector.

maximize the number of animals kept on the farm. The linear programming problem can be set in such a way that the goal of feed cost minimization is expressed by the objective function; the sum of the products of all used feeds and their prices has to be minimized. The second goal can be solved by looking at the number of animals as an independent variable having a high negative price. Then the equation which expresses the requirement of all animals for one nutrient can be developed as:

$$\begin{aligned} & a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n \geq b_1u \\ \text{or} \quad & a_{11}x_1 + a_{12}x_2 + \dots + a_{1n}x_n - b_1u \geq 0 \end{aligned} \quad (3)$$

Where:

$x_1, \dots, x_n$	$\equiv$	kinds of feed
a_{ij}	$\equiv$	contents of the nutrient in one unit of the feed
b_i	$\equiv$	the nutrient requirement of one animal
u	$\equiv$	number of animals; independent variable

With regard to constraints, the following five important limitations must be noted:

- 1) The minimum level of all important nutrients has to be secured.
- 2) However, because the animal's stomach is limited in size, it can consume only a certain quantity of feed.
- 3) Only existing acreage over and above that required for cash grain production can be used for growing feed.
- 4) There is a constant proportional ratio of weight of the different parts of a plant, which must enter in the constraints.
- 5) The limitation on purchased feed must be expressed as a constant.

* * *

In review, the first part of this thesis has presented: in the first chapter, the problem to which this study is devoted; in the second chapter,

the relevant economic theory; in the third chapter, the analytical tools used. The material presented so far has been applied to a particular farm in Census Division 5 in Alberta. This application is the basis of the case study forming the second part of the thesis.

PART II

CHAPTER 4

THE STUDY REGION

4.1 Census Division 5

Census Division 5 is located in the southern part of Alberta, east of a line going through Red Deer and Calgary. The total area of this census division is 4,144,640 acres, and the current population is about 36,000 people.¹ Typical of the open prairie, the topography of the area ranges from flat to undulating, broken only by wide, branching canyons. The region is drained by two principal rivers, the Red Deer and the Bow. The largest city in the census division is Drumheller, with an approximate population of 5,000.

4.1.1 Climate and Soil

The average April to August temperature is 55 degrees Fahrenheit. Average annual precipitation fluctuates around 15 inches, with an April to August average of 10 inches. The area is also noted for a high occurrence of hail [Paul, 1969; Petersen, 1971] and for dry winds, which cause a high degree of evaporation.

Three types of soil are found in the census division. Approximately four percent of the land area, located primarily in the southeastern part of the region, is covered by brown soil. Thin black soil in the northwestern corner and the west central portion of the division constitutes about eleven percent of the land area. The rest, that is the major part of the area, is covered by dark brown soil. Some land, mainly in the south,

¹All figures describing Census Division 5 are based on the 1966 census.

is under irrigation. The distribution of soil types is shown in the map in Figure 4.1.

4.1.2 Agriculture

Agriculture is the principal occupation in Census Division 5. Forty percent of the people live on farms. The geographical character of the country determines the main specialization for agricultural production in the area, grain production.

The census division includes 2,961,410 acres of agricultural land. In 1966, 1,670,742 acres were under crop, 1,108,153 acres were summer fallow, and 148,965 acres were improved pastures. Agricultural land comprises 71 percent of the total land in the census division, the highest percentage in the province.

The major agricultural product in this division is grain, especially wheat. The acreage of wheat is the largest in the province, with 1,093,961 acres in 1966; 1,434,453 acres of wheat, barley, and oats in total is the second largest in the province. The importance of grain production in the census division is also indicated by the classification of farms by products. Of a total of 3,556 commercial farms, 2,232 are classified as wheat producing. This figure is again the largest for any census division in the province. Using an economic criterion, the same conclusion is reached. The total value of agricultural products sold in 1965 from the division was about 65 million dollars. Of that, 33 million dollars were obtained from wheat, 40 million from all grain. This figure is 10 million dollars higher than that for any other census division in Alberta. From this predominantly wheat producing area, a typical farm was selected for case study.

SOIL ZONES OF ALBERTA

as established by
ALBERTA SOIL SURVEYS

CLIMATE—Semi-arid, characterized by an average annual precipitation of 11 to 13 inches, frequent drought, high evaporation and frequent hot dry winds.

VEGETATION—Short grass prairie.

SOIL PROFILE—In the normal profile the surface horizon (Ah) is about 5 inches deep and brown. The B horizon is commonly brownish in color and the lime horizon (C1) is found at depths averaging 16 inches below the surface. The parent material (C2) is found at depths of 14 to 24 inches. In the other zones this horizon occurs at greater depths.

FERTILITY—Moisture is the principal limiting factor in crop production. Soils in this zone are relatively low in nitrogen and phosphorus and under irrigation or in a wet year respond to fertilizers supplying these elements.

LAND USE—Only the most favorable soil types can be considered arable. Most of the area is desirable for ranching. Where farmed, wheat is the principal crop grown. Cropping practices must provide for moisture conservation and control of soil drifting. The long frost-free period makes this zone a desirable area for the development of irrigation.

DARK BROWN

CLIMATE—The average annual precipitation is 12 to 15 inches, and there are less frequent droughts than in the Brown soil zone. Fairly high evaporation and hot dry winds are added characteristics.

VEGETATION—Chiefly mixed grass prairie. The grass makes a denser cover and taller growth than in the Brown soil zone.

SOIL PROFILE—In the normal profile the surface horizon (Ah) averages about 7 inches in depth and is dark brown in color. The B horizon is brownish in color and the lime horizon (C1) is found usually at depths of 18 to 24 inches below the surface. In this zone as in other zones, the B horizon, having received some finer materials from the A, is usually somewhat finer textured and more compact than the A horizon.

FERTILITY—Moisture continues to be the principal limiting factor in crop production. Soils in this zone are relatively low in nitrogen, phosphorus and organic matter, but are higher in these constituents than soils of the Brown soil zone. Periodic applications of fertilizer are recommended.

LAND USE—Only the better soil types can be considered arable. The remainder generally is good pasture land. Wheat is grown almost to the exclusion of all other crops. Cropping practices must provide for conservation of moisture and control of soil drifting. Good quality wheat is grown in this and the other grassland zones.

THIN BLACK

CLIMATE—Annual precipitation averages between 14 and 17 inches. The higher rainfall is in the southern part of the province where there is a correspondingly higher evaporation. Droughts occur only occasionally.

VEGETATION—Grassland in which bluffs of trees are found in places where moisture conditions are more favorable.

SOIL PROFILE—The normal profile has an Ah horizon that averages about 10 inches in depth and in its upper 1 to 6 inches is black in color. The remainder is usually dark brown. The B horizon is usually brown to dark brown and the lime horizon (C1) is found at depths of 20 to 30 inches below the surface. Generally the depth to the lime layer is considered as indicative of the efficiency of rain penetration.

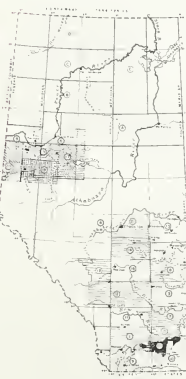
FERTILITY—Soils in this zone may be fairly well supplied with nitric acid and organic matter but are usually deficient in phosphorus. In any case extensive cropping depletes the soils native nutrient supply and fibre. Good soil management, involving crop rotations and the use of fertilizers, is essential for the adequate replacement of depleted plant nutrients and the maintenance of organic matter.

LAND USE—A greater number of soil types can be considered arable than in the Brown soil zone. Wheat is the principal crop grown, but considerably more diversification is possible and should be practiced to maintain soil fertility. Non-arable land is generally very good pasture.

DOMINANTLY SOLONETZIC SOILS
Cley pan soils developed on saline parent material.

DOMINANTLY ORGANIC SOILS
Poorly drained soils with a thick accumulation of peat.

LOCATION OF SURVEYED AREAS FOR WHICH SOIL REPORTS AND MAPS HAVE BEEN PUBLISHED



- * 1. Macleod sheet
- * 2. Medicine Hat sheet
- * 3. Sounding Creek sheet
- * 4. St. Ann sheet
- * 5. Dunvegan sheet
- * 6. Peace River, High Prairie
- * 7. Sturgeon Lake area
- * 8. Rainy Hills sheet
- * 9. Lethbridge and Picher Creek sheets
- * 10. Milk River sheet
- * 11. Brackford and Calgary sheets
- * 12. Resboul and Banff sheets
- * 13. Vermilion and Wainwright sheets
- * 14. Peace Hills sheet
- * 15. Rycroft and Watino sheets
- * 16. Red Deer sheet
- * 17. High Prairie and McLennan sheets
- * 18. Grande Prairie and Sturgeon Lake sheets
- * 19. Rocky Mountain House sheet
- * 20. Beaverlodge and Big Horn Mountain sheets
- * 21. Edmonton sheet
- * 22. St. Mary and Milk Rivers Development area

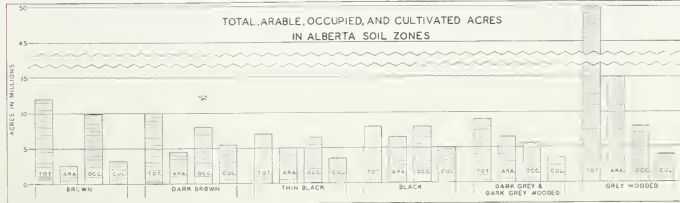
(A) Preliminary 58-1; (B) Preliminary 59-1;
(C) Preliminary 60-1; (D) Preliminary 61-1.

*Reports for areas 1 to 8 inclusive are out of print but may be obtained or loan from the Ericsson Library, University of Alberta, Edmonton. Reports for areas 9 to 22 inclusive can be obtained from the Department of Extension, and the preliminary reports from the Research Council of Alberta, University of Alberta, Edmonton.

BASE MAP BY THE DEPARTMENT OF LANDS AND FORESTS, EDMONTON, ALBERTA

Figure 41
Soil Zones of Alberta

Arranged and Drawn by
WM. ODYSKY
RESEARCH COUNCIL OF ALBERTA
THIRD EDITION
REVISED JANUARY, 1962



CLIMATE—Annual precipitation averages between 17 and 19 inches and droughts are rare. Evaporation is lower and hot winds less frequent than in the previous zones.

VEGETATION—Grassland which has been partially invaded by woodlands (mainly deciduous trees), often referred to as a parkland.

SOIL PROFILE—The normal profile has a black to very dark brown surface horizon (Ah) that averages 12 to 14 inches in depth. The more compact B horizon is brown to dark brown, and the lime horizon (C1) is usually found at 24 to 40 inches below the surface.

FERTILITY—Soils in this zone are the most fertile in the province and they have, in the surface foot, 2 to 4 times as much nitrogen and organic matter as there is in the average Brown or Gray Wooded soil. Every precaution should be taken to use that they are not allowed to deteriorate. The use of fertilizer to replenish the supply of available nitrogen and phosphorus is usually a good investment.

LAND USE—A high percentage of the zone is arable. Wheat of fairly good quality can be grown, but mixed farming, including the use of crop rotations and fertilizers is desirable from the standpoint of both profit and permanence.

DARK GREY AND DARK GREY WOODED

CLIMATE—Annual precipitation averages from 12 inches in the northern section to about 20 inches in the south. Evaporation is lower than in the previous zones.

VEGETATION—Mainly woodland in which the tree growth is frequently denser and has more evergreens than in the Black zone.

SOIL PROFILE—Generally variable, ranging from nearly black to grey. The surface horizon consists of a thin layer of semi-decomposed leaf litter (LH) which may be absent in burned over areas, underlain by a mineral horizon that can usually be divided into two parts. The upper part (Ah) may be black, grey black, or dark brown. The lower part (Aa or Ab) is frequently somewhat leached of organic matter and considerably greyer than the Ah. The total depth of these surface horizons averages about 10 to 12 inches. The B horizon is generally dark brown in color and lime is found at depths of about 10 to 20 inches.

FERTILITY—These soils are usually not as rich as those of the Black zone. Leaching of the surface horizons has resulted in the loss of some plant nutrients. Nitrogen, phosphorus and sometimes sulphur may be deficient.

LAND USE—A system of mixed farming that includes legumes and grains in the crop rotation, supplemented with applications of fertilizer when required, should be practiced for best results.

GREY WOODED

CLIMATE—Annual precipitation averages from about 12 inches in the northern section to about 20 inches in the southern. This is accompanied by cooler temperatures, lower evaporation, and shorter growing seasons than those of the previous zones.

VEGETATION—A mixed deciduous and evergreen woodland in which moss bogs (muskeg) and sedge bogs are of common occurrence.

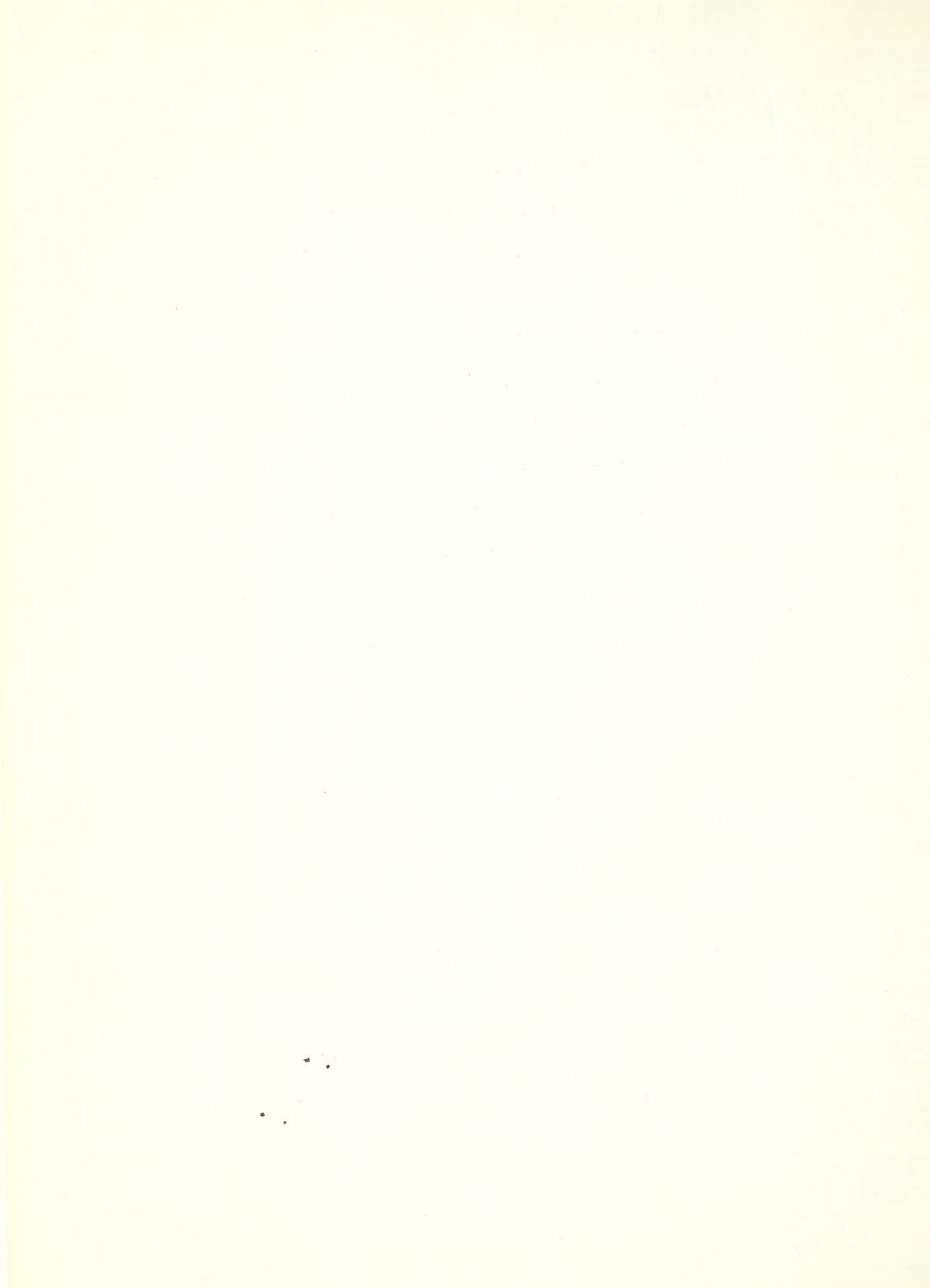
SOIL PROFILE—These soils have developed under humid soil moisture conditions. The surface horizon consists of semi-decomposed leaf litter (LH) that may be absent if the area has been burned over; a thin (sometimes absent) Ah horizon that may be grey black, brown or grey brown, and a severely leached and platy, greyish A horizon, whose depth will average about 6 to 8 inches. The B horizon is finer textured, compact, and often darker in color than the A. The depth to lime is quite variable, often ranging from 30 to 50 inches.

FERTILITY—Soils in this zone are relatively less fertile because of leaching. They are usually deficient in nitrogen, phosphorus, organic matter, and sometimes in sulphur.

LAND USE—Mixed farming in which legumes, hay, and coarse grains are the most desirable crops. Rotations including legumes and grains, supplemented with fertilizers, have given the most satisfactory results.

BROWN WOODED AND ACID BROWN WOODED
(Preliminary outline subject to further study.)

AREA NOT EXPLORED BY SOIL SURVEY
Believed to have Grey Wooded, other Pedologic soils and Organic Soils.



4.2 A Typical Farm

The single farm case study method is used when it is decided that a particular example can better approach a problem than theoretical analysis and when an actual case study is deemed more reliable than an artificially created situation. These conditions are met in this study. A typical farm was selected to represent the majority of farms in the area in order to examine the feasibility of the semi-drylot method of cow-calf production on Alberta wheat land.

Using a typical farm means that research results will be relevant to a maximum number of farms. The term "typical farm" does not have any statistical or scientific definition.¹ In this study it is used in a common and generally known sense. The nature of the criteria used for its selection is somewhat subjective. Only fundamental characteristics of the farm may usefully be compared to statistical means and modes of the census division. These might include size in terms of acreage, the type of farm with respect to main products sold, and type of soil.

4.3 The Selected Farm

The farm of Mr. Brown² was chosen as representative for the following reasons.

First, the farm is believed to be typical based on the author's personal observations during study trips to the census division.

¹The term "typical farm" may tend to be associated with calculations of statistical measurements of central tendency, such as the mean, the median, and the mode [Richmond 1964, Spiegel 1961]. Such measurements are appropriate when dealing with single features, but they are not applicable when selecting a specific farm that should reflect a whole host of complex and interrelated features.

²A hypothetical name is used for an actual farm.

Second, comparison with statistical averages for the census division favors its selection. The largest number of farms classified by size of farm (834) lie in the range of 760 - 1,119 acres. The second largest number (622) lie in the range of 1,120 - 1,599 acres [DBS 1968, tab 13]. The size Mr. Brown's farm is 1,120 acres. According to classification by "improved land," the largest number of Census Division 5 farms (779) lie in the range of 760 - 1,119 acres. Mr. Brown's farm figure here is 1,000 acres.

Third, as mentioned before, out of a total of 3,556 farms, 2,232 have wheat as a main product [DBS 1968, tab 16]. Mr. Brown's farm is one of these.

Fourth, on the selected farm, records are well kept, thus providing a reliable source of data.

Fifth, the farm has the dominant topography (slightly rolling land with some branch canyon or coulee) and soil (dark brown) of the area.

Last, but not least, is Mr. Brown's personal interest in the results.

4.3.1 Characteristics of the Farm

Mr. Brown's farm is located a few miles southeast of Drumheller close to the main Red Deer River Valley. The total size of the farm is 1,120 acres, of which 1,000 acres are cultivated land, 110 acres are wild pasture and coulee, and 10 acres are farmstead.

Mr. Brown's property consists of two parcels (three-quarters of a section and a full section) lying one and one-half miles apart. The farm is sketched in Figure 4.2.

Farming methods and cultural practices, as well as equipment, machinery, and labor and financial resources on Mr. Brown's farm, are characteristic of the study area. The summer fallow method is applied for crop production. One-half of the cultivated land (500 acres) is used for wheat, barley, and

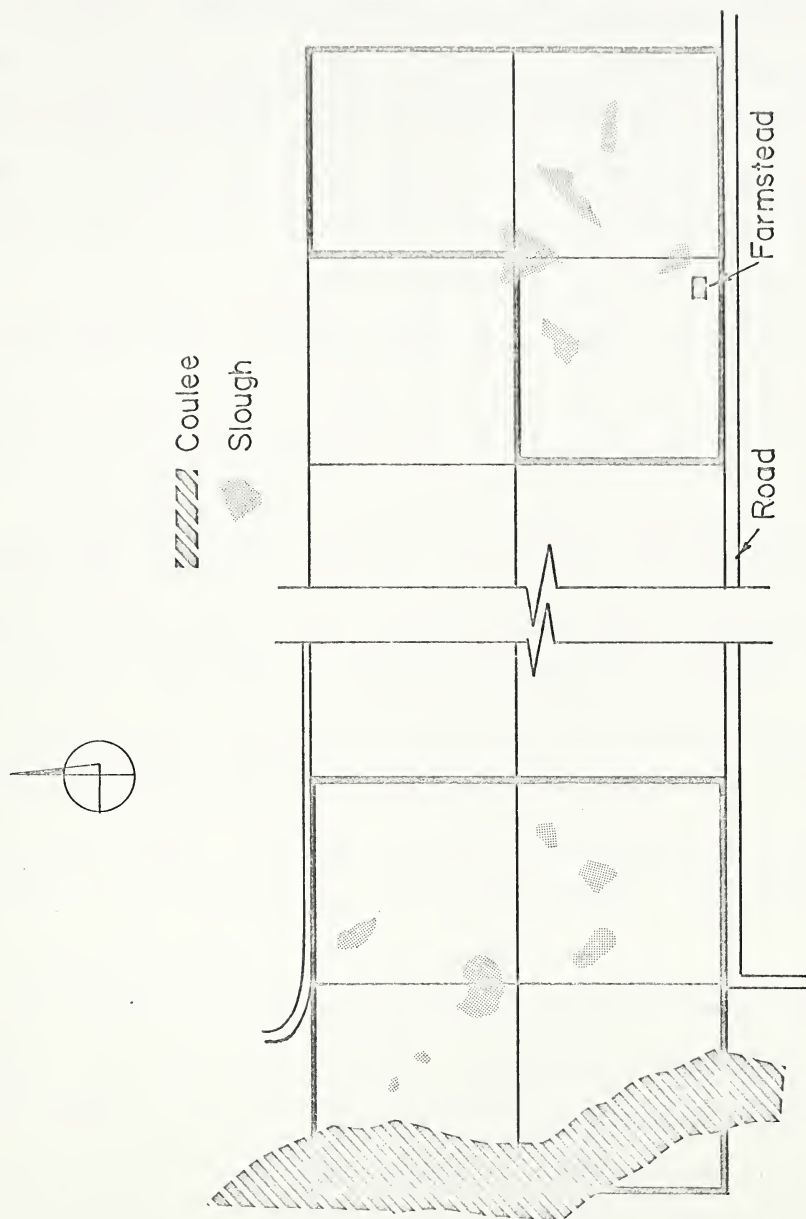


Figure 4.2

MR. BROWN'S FARM

oat production; the other 500 acres is normally fallow land. Grain is the only type of crop production.

Like most neighboring farmers, Mr. Brown uses the practice of seeding with a discer, harvesting with a swather and a combine, and tilling with a deep tillage cultivator. As on the other farms, some cattle (about twenty head) are already kept on the farm to utilize the wild pasture. Hence, a typical farmer in the area would be somewhat experienced in animal husbandry.

A list of farm machinery is given in Appendix D. However, it should be noted here that the farmer already owns a baler, which is important for the cow-calf operation. A chaff collector, which may be required for the semi-drylot cow-calf operation, does not appear in the farm inventory.

Also significant from the point of view of the proposed enterprise is the fact that the farm already has a fenced area and good water facilities, such as a small creek on the wild pasture, and natural ponds or sloughs.¹

Normally farm labor is supplied by the operator himself. However, during the seasonal peaks (seeding and harvest periods) outside labor is usually employed. This may involve hiring one or two persons for a period of approximately two months. A surplus of labor, which could be utilized for an expanded cow-calf operation, exists in the winter, early spring, early summer, and later fall months.

The economic situation of the farm is characterized by the following figures. The total value of land is approximately 104,000 dollars, and the present market value of the farm machinery is estimated at 18,000 dollars. The average annual gross farm revenue is 28,000 dollars, of which approximately 21,000 dollars represents cash receipts and 7,000 dollars, increase

¹Ponds in the field are required for aftermath grazing during some periods of the year.

in crop inventories. Annual cash operating expenses for an average year have been 14,000 dollars, depreciation 4,500 dollars. Thus, total expenses of the farm presently add up to 18,500 dollars a year. This means that net farm income for an average year has been in the vicinity of 9,500 dollars.

The effect on net farm income of expansion of the existing cow-calf operation on a semi-drylot basis is the subject of the next chapter.

CHAPTER 5

DATA COLLECTION, ANALYSIS, AND RESULTS

Data has been collected and analyzed in order to calculate the amount of land that should be devoted to the cow-calf operation, the least-cost combination of feeds, and the final partial budget to determine profitability. The main source of data was written records and reported information from Mr. Brown's farm. Secondary data (such as technical input and output coefficients) have been obtained from various publications.¹

5.1 Determination of Acreage for the Cow-Calf Enterprise

It is assumed that most of the feed will be produced on the farm. Therefore, the acreage of land to be reserved for feed production must be calculated. This is done using the following criteria.

The farmer wishes to produce and sell through regular channels as much grain as possible. Accordingly, the past five years' average for each grain sold through Canadian Wheat Board quotas was calculated. This figure was divided by average yields for the farm to give the required acreage for the cash crops, namely wheat, barley, and oats. The difference between the total cultivated land and the total land used for cash crops represents the area available for feed production for the proposed cow-calf operation.

The results of the above calculations are summarized below.

¹Specific references are given where necessary later in the chapter.

170 acres of wheat

63 acres of barley

30 acres of oats

263 acres of cash crops

Recalling that 500 acres is under crop every year, the area available for feed production is 237 acres. Analysis of average cash crop composition will serve as the basis for estimating the total supply of cash crop side products available for feeding purposes.

5.2 The Least-Cost Combination of Feeds for the Cow-Calf Enterprise

Linear programming has been used to specify the least-cost combination feed ration. The feed ration has been calculated on a year-round basis, with the objective of examining the feasibility of cow-calf production using grain land as a feed source. Selection of the exact daily ration is left to the farmer under the assumptions that:

- 1) the farmer has a basic understanding of feeding cattle;
- 2) the practical organization depends on some unforeseen conditions, such as weather;
- 3) the exact, computed feed ration will be subject to some losses caused by free feeding to animals;
- 4) wild pasture is not counted because it will approximately compensate for these losses;
- 5) some forms of feeding, such as aftermath grazing, are predetermined by the total farm organization;
- 6) all considered feeds can be stored and fed on a year-round basis; thus no major problems regarding seasonality of feeding will arise.

5.2.1 Formulation of the Linear Programming Problem

The general application of linear programming to the cow-calf feed ration problem was described in Chapter Three (Section 3.2.2). The problem as it relates to a specific situation will now be discussed. The majority of independent variables listed in Table 5.1 refer to kinds of feed under consideration. The last variable, x_{25} , refers to the number of herd management units. A herd management unit is one cow plus its calf and replacement.¹

The objective function is set up to minimize the cost of feed. However, because the variable x_{25} enters the objective function, the value of the objective function will not show the least-cost of feed. In order to obtain the least-cost figure, the value of herd management units (x_{25} times its price) must be excluded from the final value of the production function.²

Table 5.2 is a list of the specific constraints, which were described generally in Chapter Three.

5.2.2 Data Requirements, Collection, and Preparation

For the linear programming model, three types of data are necessary. These are "prices" for the objective function, coefficients for the left-hand matrix, and the constraints themselves.

Units of measurement used are dictated by the nature of the data. The apparent inconsistency in the use of two different measurement systems (metric and British) is explained by the fact that although the table of nutrient requirements is presented in the metric system, area units are more under-

¹The exact structure of a herd management unit is presented in Appendix C.

²In practice, this means adding the value of herd management units because, given the nature of the constraints, the price of a herd management unit will have a negative sign.

Table 5.1

LIST OF THE INDEPENDENT VARIABLES FOR THE LINEAR PROGRAMMING PROBLEM

Symbol	Type of feed	Source of feed
x1	wheat grain	
x2	wheat straw	
x3	wheat chaff	
x4	wheat hay	
x5	barley grain	
x6	barley straw	feeds that will be produced only for feeding purposes
x7	barley chaff	
x8	barley hay	
x9	oat grain	
x10	oat straw	
x11	oat chaff	
x12	oat hay	
x13	vitamins A,D,E	
x14	range minerals	commercial feed complements
x15	cattle minerals	
x16	wheat straw	
x17	wheat chaff	
x18	barley straw	side products from cash crop production
x19	barley chaff	
x20	oat straw	
x21	oat chaff	
x22	wheat straw	
x23	barley straw	feeds that can be purchased in the neighborhood
x24	oat straw	
x25	number of herd management units	

Table 5.2

LIST OF THE CONSTRAINTS FOR THE LINEAR PROGRAMMING PROBLEM

Symbol	Nature of constraints	Subset
c ₁	minimum dry matter requirement	
c ₂	minimum digestible protein requirement	
c ₃	minimum metabolic energy requirement	
c ₄	minimum calcium requirement	
c ₅	minimum phosphorus requirement	I
c ₆	minimum vitamin A requirement	
c ₇	minimum vitamin D requirement	
c ₈	minimum vitamin E requirement	
c ₉	maximum dry matter limit	
c ₁₀	limitation of the area	II
c ₁₁	fixed proportion of wheat straw and grain	
c ₁₂	fixed proportion of wheat chaff and grain	
c ₁₃	fixed proportion of barley straw and grain	III
c ₁₄	fixed proportion of barley chaff and grain	
c ₁₅	fixed proportion of oat straw and grain	
c ₁₆	fixed proportion of oat chaff and grain	
c ₁₇	limitation on wheat straw from cash crop production	
c ₁₈	limitation on wheat chaff from cash crop production	
c ₁₉	limitation on barley straw from cash crop production	
c ₂₀	limitation on barley chaff from cash crop production	IV
c ₂₁	limitation on oat straw from cash crop production	
c ₂₂	limitation on oat chaff from cash crop production	
c ₂₃	limitation on total purchased straw	

¹There are two reasons why purchased straw was restricted. It was assumed that transportation cost and the desire of neighbors to retain straw for prevention of wind erosion would limit the amount of straw which could be economically purchased.

standable to the contemporary farmer if expressed in terms of acres.¹

5.2.2.1 "Prices"

Feeds to be produced on the farm, as listed in Table 5.1, have been priced at their average variable costs for the years 1966-1970 inclusive. The original information was obtained either from farm record books and/or from interviews with Mr. Brown. No other costs except the direct variable cost (that is, no fixed costs or overhead) have been considered because they have no influence on selection of feeds for the ration; neither are these costs affected by feed selection, which follows from the assumptions.

The price of wheat grain (x_1) was computed as follows:

Average cost of seed per acre	\$ 2.71
Average cost of fertilizer per acre	\$ 3.80
Average cost of fuel per acre	\$ 1.72
Average cost of repairs	\$ 3.58
Average variable cost per acre	\$11.81

The cost of fuel has been increased by twenty-five percent from the original level assuming higher transportation activity for the cow-calf operation. Also the cost of repairs is slightly higher because of the addition of a chaff collector and a baler. The acreage yield of wheat was calculated at 39.8 bushels, or 1,082.5 kilograms, per acre. Therefore, the direct variable cost per kilogram of wheat is:

$$\$11.81 \div 1,082.5 \text{ kg} = 1.090\text{¢/kg.}$$

The prices for other grain were obtained using the same procedure. The

¹For weight units, the conversion factor 1 kg = 2.2046 lb was used when necessary.

direct variable components are the same except costs for seed; average seed costs of barley and oats were appraised at \$2.41 and \$2.50 per acre respectively. Seed costs include cost of cleaning.

For straw and chaff only the costs of collection are needed. These include costs of fuel and repairs. Considering that regular grain production requires five machine operations per field, costs per acre associated with straw and chaff collection have been estimated at one-fifth of the relevant cost components. The prices of commercial vitamins and minerals were taken from a feed company price list [North West Feeds Company, 1971]. The cost of straw or chaff will be the same whether it is from feed production or cash crop production. Consequently, the price of x_6 , for example, is equal to the price of x_{18} . The price of purchased straw was appraised considering two factors, namely the average price of straw reported by the farmer, and business custom whereby half of the straw baled by the purchaser is usually given to the owner. The price of a herd management unit does not represent market price. Its large magnitude and negative sign are to ensure that the number of herd management units will be as large as would be technically feasible under the existing feed constraints. It does, however, approximate the revenue per year from one herd management unit.

A complete list of prices of all the variables is presented in Table 5.3.

5.2.2.2 Coefficients

The coefficients of the first subset of constraints were directly derived from tables of nutrient composition of feed and of animal requirements for nutrients [National Academy of Sciences, 1970]. However, the original figures cannot be used directly for this purpose. Some had to be

Table 5.3

PRICES OF VARIABLES FOR THE LINEAR PROGRAMMING PROBLEM

(cents per unit)

Variable	Unit	Price	Variable	Unit	Price
x_1	kg	1.090	x_{14}	kg	21.710
x_2	kg	0.500	x_{15}	kg	13.230
x_3	kg	0.238	x_{16}	kg	0.500
x_4	kg	0.868	x_{17}	kg	0.238
x_5	kg	0.979	x_{18}	kg	0.431
x_6	kg	0.431	x_{19}	kg	0.196
x_7	kg	0.196	x_{20}	kg	0.494
x_8	kg	0.846	x_{21}	kg	0.235
x_9	kg	1.058	x_{22}	kg	1.102
x_{10}	kg	0.494	x_{23}	kg	1.102
x_{11}	kg	0.235	x_{24}	kg	1.102
x_{12}	kg	0.852	x_{25}	no.-12,800,000	
x_{13}	kg	19.400			

recalculated according to given formulas [National Academy of Sciences, 1970, pp.18-20]. In the first subset the actual constraints (even though they appear on the left-hand side) are the coefficients of the variable x_{25} . As mentioned, they refer to annual nutrient requirements per herd management unit.

The meaning of the coefficients of the second subset is the area in acres required to produce one kilogram of feed. In fact, the coefficients are equivalent to the inverse yields.

The coefficients for the third subset express the proportional quantity of by-products from grain production (straw and chaff) that is obtainable by production of one unit of grain [Singh, 1971]. The fact that a certain amount of straw (about 1,500 pounds) should remain on the field to protect it against wind erosion is considered [Canada Department of Agriculture, 1966, p.10].

The fourth subset of constraints pertains to the restriction of those feeds which are available only in limited quantity (by-products from cash crop production and purchased straw). In such cases the coefficients of the left-hand side are unity.

5.2.2.3 Constraints

The right-hand side of the set of constraints is made up of:

- 1) zeros in the first and third subsets;
- 2) acreage devoted to feed production (as determined in Section 5.1) in the second subset;
- 3) actual supply of feeds in subset four.

The constraints of the fourth subset, except c_{23} , were calculated by the following formula:

$$\text{constraint} = \text{land for cash crop} \times (\text{yield} \times \text{by-product to grain ratio}),$$

where the by-product to grain ratios have already been calculated

for the left-hand side of the third subset as coefficients. (4)

The above linear programming problem was solved on the IBM-360, Model 67 system computer. Next, the problem was modified by introducing the assumption that the purchased feeds were not available for some reason. In terms of the original linear program, this assumption implies that the variables x_{22} , x_{23} , and x_{24} are missing.

The results of both programs are presented in Table 5.4. The results show that all 237 acres would be devoted to growing oats under Program I, and approximately 225 acres to oats and 12 to barley under Program II. All side products from cash crop production must be used under both programs. Under Program I, considered limits of straw (100,000 kg) must be purchased. This would be approximately 100 tons, utilizing only oat straw, which could be purchased from neighbors.

5.3 Effect of the Cow-Calf Operation on Net Farm Income

The partial budgeting method has been used to estimate overall effects of undertaking the semi-drylot method of cow-calf enterprise on the grain farm selected for case study. It may be recalled that prior to setting up a partial budget, the situation to which the partial budget refers must be clearly defined and understood. Only those items which are directly influenced by the planned change should be incorporated into the partial budget.

Table 5.4

RESULTS OF THE LINEAR PROGRAMS

Variable	Symbol	Unit	Level of Activity	
			Program I with purchased feed	Program II without purchased feed
Wheat grain	x ₁	kg	--	--
Wheat straw	x ₂	kg	--	--
Wheat chaff	x ₃	kg	--	--
Wheat hay	x ₄	kg	--	--
Barley grain	x ₅	kg	--	13,947.3
Barley straw	x ₆	kg	--	3,919.2
Barley chaff	x ₇	kg	--	1,952.6
Barley hay	x ₈	kg	--	--
Oat grain	x ₉	kg	259,526.9	246,537.3
Oat straw	x ₁₀	kg	65,400.8	62,127.4
Oat chaff	x ₁₁	kg	32,700.4	31,063.7
Oats hay	x ₁₂	kg	--	--
Vitamins A,D,E	x ₁₃	kg	3,237.4	1,339.8
Range minerals	x ₁₄	kg	--	--
Cattle minerals	x ₁₅	kg	587.9	1,095.7
W.straw - c.c.	x ₁₆	kg	46,240.0	46,240.0
W.chaff - c.c.	x ₁₇	kg	23,120.0	23,120.0
B.straw - c.c.	x ₁₈	kg	20,790.0	20,790.0
B.chaff - c.c.	x ₁₉	kg	10,395.0	10,395.0
O.straw - c.c.	x ₂₀	kg	8,280.0	8,280.0
O.chaff - c.c.	x ₂₁	kg	4,140.0	4,140.0
W.straw - purch.	x ₂₂	kg	--	--
B.straw - purch.	x ₂₃	kg	--	--
O.straw - purch.	x ₂₄	kg	100,000.0	--
Number of H.M.U.	x ₂₅	no.	137	113
Value of obj. function		\$	- 12,135.11	- 10,498.85
Min. cost of feed		\$	5,400.89	3,965.15

5.3.1 The Situation

A cow-calf enterprise is to be substituted for part of the current cash grain production. Specifically, the land currently devoted to cash crop production is to be reduced by 237 acres in accordance with Canadian Wheat Board quotas. If some straw is purchased from outside the farm, 137 herd management units can be maintained on the farm; if no straw is purchased, 113 herd management units can be kept.¹ The cow-calf production is to be carried out by the semi-drylot method.

The only market products from the proposed enterprise will be calves and cull cows. Calves will be sold after retaining the number required for replacement. This implies that all replacements will be secured from the herd itself. The culling ratio and the calf/crop ratio, as well as other relevant technical coefficients, are presented in the next section. As indicated in Section 5.2 on least-cost feed ration determination, barley, oats, their side products, and wheat straw and chaff are to be used as feeds. This agrees with the specified goal of a minimum change in current practices and machinery inventories of the farm (Section 1.2).

5.3.2 Assembly and Preparation of Data

To make up the partial budget, data from various sources have been obtained and organized. The following are the specifications for the general application of partial budgeting to the cow-calf enterprise as discussed in Section 3.1.4.

Revenue from selling calves and cull cows represents added returns.

¹The structure of the herd for both alternatives is given in Appendix C.

For this calculation the number of animals in both of the above categories and their market prices are required. The number of animals is predetermined by the calf/crop ratio of 90 percent, the culling ratio of 15 percent, and the number of herd management units calculated previously by linear programming. The prices for both categories of animals have been calculated from the records of the Calgary Stockyards and adjusted for transportation costs. For the years 1966 to 1970 inclusive, the average prices of calves and cull cows are 31.25 cents per pound and 17.51 cents per pound; the assumed weights are 450 pounds and 1,000 pounds respectively.

When calculating reduced costs, only variable costs are relevant in this situation. Reduced fixed cost does not occur given the circumstances. Reduced variable cost is made up of direct variable costs of the 237 acres of cash grain production, which is to be replaced by feed production for the cow-calf enterprise. It consists of direct variable costs for each grain multiplied by the number of acres, plus storage costs. Information sources are the farm records for the years 1966-1970 and the farmer's estimation in the case of storage costs. The figures used in these calculations are summarized in Table 5.5.

Added costs include the extra costs of adding the cow-calf enterprise. They include both fixed and variable costs resulting from the fixed costs of interest on additional investments in the purchased cattle, some added fences and corrals, and machinery and equipment directly related to the beef enterprise. To calculate investment in purchased cattle, numbers have been derived from the computation of herd management units.. The price of a breeding cow is 23.42 cents per pound, based on Calgary Stockyard averages for 1966 to 1970. The average weight was estimated at 900 pounds per animal. It is also assumed that in the second year, replacement heifers would have to be purchased for an average price of 25.71 cents per pound at approximately 800 pounds of body

Table 5.5

COMPONENTS OF THE REDUCED VARIABLE COSTS

Grain	Direct variable cost per acre (\$)	Number of acres	Storage cost (\$)
Wheat	10.91	161	150
Barley	10.61	54	60
Oats	10.70	22	50

Table 5.6

COMPONENTS OF REDUCED REVENUE

Grain	Acreage (ac)	Yield (bu/ac)	Price (\$/bu)
Wheat	161	39.8	75
Barley	54	54.0	50
Oats	22	71.0	40

weight. The additional investment in cattle facility improvements is estimated at 300 dollars. A chaff collector and wagon for the combine will cost 1,000 dollars, other extra equipment, 300 dollars. The annual interest charge is taken as 8.5 percent, a rate approximating that for average farm loans.

Added variable costs consist of feed cost and other operating costs. The feed cost, derived from the linear programming problem, is \$5,400.89 and \$3,965.15 for Programs I and II respectively. The services include insemination (the form of artificial insemination is considered under the assumption that the costs of natural and artificial insemination are approximately the same) and veterinary services. Based on the farmer's report, a cost of 20 dollars per herd management unit is used to cover both insemination and veterinary services (10 dollars each).

Reduced revenues are represented by the value of grain previously sold through nonofficial market channels at reduced prices. The components of reduced revenues have been calculated from the 1966-1970 farm records (acres and yields) and from estimates by the farmer (prices). The list of figures for the components appears in Table 5.6.

5.3.3 The Partial Budget

A summary of the above material is compiled in the conventional partial budget form in Tables 5.7 and 5.8. Some anticipated data may in fact vary from the specified values utilized in this compilation. This would alter the final result. Taking this fact into account for each relevant component separately (while holding the values of all other components constant), it is possible to calculate the extreme feasible level of the component that will cause the change in net income to be equal to zero.

Table 5.7

THE PARTIAL BUDGET FOR PROGRAM I
(With Purchased Straw)

Item	\$
<u>Advantages.</u>	
1. <u>Added Returns.</u>	
Revenue from calves $\{[(137 \times 0.90) - (137 \times 0.15)] \times 450\} \times 0.3125$	14,449.22
Revenue from cull cows $[(137 \times 0.15) \times 1,000] \times 0.1751$	3,598.30
Total Added Returns	18,047.52
2. <u>Reduced Costs.</u>	
A. Fixed Costs	Nil
B. Variable Costs	
of reduced wheat acreage $(161 \times 10.91) + 150$	1,926.51
of reduced barley acreage $(54 \times 10.61) + 60$	632.94
of reduced oats acreage $(22 \times 10.70) + 50$	285.40
Total Reduced Costs	2,844.85
Total Advantages	20,892.37

(Cont'd)

Table 5.7 (Continued)

Item	\$
<u>Disadvantages.</u>	
3. <u>Added Costs.</u>	
A. Fixed Costs	
Interest on additional herd investment $\{(137 \times 900 \times 0.2342) + [(137 \times 0.15) \times 800 \times 0.2571]\} \times 0.085$	2,813.80
Interest on other added investment in beef facilities	
Buildings (300×0.085)	25.50
Machinery $(1,000 \times 0.085)$	85.00
Others (300×0.085)	25.50
Total Fixed Costs	2,949.80
B. Variable Costs	
Feed	5,400.89
Veterinary services (137×10)	1,370.00
Insemination services (137×10)	1,370.00
Total Variable Costs	8,140.89
Total Added Costs	11,090.29
4. <u>Reduced Revenues.</u>	
From nonquota wheat $(161 \times 39.8 \times 0.75)$	4,805.85
From nonquota barley $(54 \times 54.0 \times 0.50)$	1,458.00
From nonquota oats $(22 \times 71.0 \times 0.40)$	1,562.40
Total Reduced Revenues	7,826.25
Total Disadvantages	18,916.54
Change in Net Income $(20,892.37 - 18,916.54)$	1,975.83

Table 5.8

THE PARTIAL BUDGET FOR PROGRAM II
(Without Purchased Straw)

Item	\$
 A d v a n t a g e s .	
1. <u>Added Returns.</u>	
Revenue from calves $\{[(113 \times 0.90) - (113 \times 0.15)] \times 450\} \times 0.3125$	11,917.96
Revenue from cull cows $[(113 \times 0.15) \times 1,000] \times 0.1751$	2,967.94
Total Added Returns	14,885.90
2. <u>Reduced Costs.</u>	
A. Fixed Costs	Nil
B. Variable Costs	
of reduced wheat acreage $(161 \times 10.91) + 150$	1,926.51
of reduced barley acreage $(54 \times 10.61) + 60$	632.94
of reduced oats acreage $(22 \times 10.70) + 50$	285.40
Total Reduced Costs	2,844.85
Total Advantages	17,730.75

(Cont'd)

Table 5.8 (Continued)

Item	\$
D i s a d v a n t a g e s .	
3. <u>Added Costs.</u>	
A. Fixed Costs	
Interest on additional herd investment { (113 x 900 x 0.2342) + [(113 x 0.15) x 800 x 0.2571] } x 0.085	2,320.87
Interest on other added investment in beef facilities	
Buildings (300 x 0.085)	25.50
Machinery (1,000 x 0.085)	85.00
Others (300 x 0.085)	25.50
Total Fixed Costs	2,456.87
B. Variable Costs	
Feed	3,965.15
Veterinary services (113 x 10)	1,130.00
Insemination services (113 x 10)	1,130.00
Total Variable Costs	6,225.15
Total Added Costs	8,682.02
4. <u>Reduced Revenues.</u>	
From nonquota wheat (161 x 39.8 x 0.75)	4,805.85
From nonquota barley (54 x 54.0 x 0.50)	1,458.00
From nonquota oats (22 x 71.0 x 0.40)	1,562.40
Total Reduced Revenues	7,826.25
Total Disadvantages	16,508.27
Change in Net Income (17,730.75 - 16,508.27)	1,222.48

This extreme value for each pertinent component is calculated in Table 5.9.

5.4 The Labor Problem

In this study it has been assumed that unused labor is available to the operator during certain seasons of the year which can be used to manage the beef herd. This assumption is realistic for the majority of grain farms. However, the presence of approximately 150 beef animals (cows and young heifers) on the farm will greatly change seasonal labor requirements and the overall labor situation. The suggested program will require good organization of the cow-calf enterprise so that periods of heavy labor inputs do not conflict with requirements for crop production. Daily general management, periodical supply of feed, and the occasional treatment of normal defects should not require more than one hour a day on the average. Thus the ordinary daily time requirement need not present a serious problem. Difficulties would arise only if the peaks of both grain and cow-calf labor requirements were to coincide. Careful distribution of breeding, calving, insemination, and selling calves between grain production labor peaks, however, can eliminate such a problem.

Assuming that cow-calf production will be organized so that all calving occurs in March, the following distribution of seasonal peaks should ensure a smooth running of the farm with respect to labor utilization.

March:	Calving of breed cows and heifers.
April:	Preparation of soil for seeding.
May:	Seeding and fallow tillage.
June:	Insemination of cows and heifers.
July:	Tillage of summer fallow.

Table 5.9

EXTREME BREAK-EVEN VALUES OF SELECTED COMPONENTS

Component	Extreme Value	
	Program I	Program II
Price of calf	26.98¢/lb	28.04¢/lb
Interest rate	14.19%	12.73%
Average value of feed per H.M.U.	\$53.84	\$45.90
Increase of nonquota grain prices	25.25%	15.62%

August:	Swath and tillage of fallow.
September:	Harvest and fall tillage.
October:	
November:	Selling calves.
December:	
January:	Repairs and general maintenance on the farm.
February:	Budgeting.

The organization of feeding methods during the year is given in Appendix B of this study. While labor management will be greatly increased under the above proposal, there is little published literature to indicate labor requirements under this type of production method. However, several farmers operating similar units were interviewed.¹

¹For example an Acme farmer, who cultivates 1000 acres and maintains 100 breeding cows on a one man basis, with a small amount of hired labor during harvest time.

CHAPTER 6

CONCLUSIONS, RECOMMENDATIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

6.1 Conclusions

From the results presented in the previous chapter, objectives of the study can be evaluated and the hypothesis either accepted or rejected. It appears possible for the typical farm operator in Central Alberta to utilize the semi-drylot method of cow-calf production as one alternative solution to the surplus grain and beef shortage problems. In other words, the study supports the hypothesis that the semi-drylot method is economically possible for a typical wheat producing farm under certain conditions.

There are two groups of conditions under which the proposed cow-calf enterprise is profitable. The first group includes conditions over which a farmer has negligible control. These conditions are presented in Table 5.9. It can be observed that the price of a calf must be quite high before the cow-calf enterprise begins to be profitable; 26.98 or 28.04 cents per pound respectively for the two alternative plans. The price of grain salable to a neighbor, however, has to be low in order to ensure some positive change in annual net farm income by the introduction of a cow-calf enterprise. Increasing the price of grain by 25 percent or even 15 percent respectively would mean the loss of all positive change in net income. The value of feed per cow is partially under the farmer's control, but the market price of feed production resources is not.

The harmonized distribution of grain and beef production labor peaks is largely under the farmer's control. This thesis assumes a high ability on the part of the farmer. However, failing fulfilment of this condition,

shortages in seasonal labor might occur, necessitating the use of hired labor and resulting in apparent nonprofitability of the beef enterprise.

6.2 Recommendations

The economic effect of the new enterprise on the typical farm has been shown using Mr. Brown's as the case study farm with the tools of linear programming and partial budgeting.

Results of the study show that Mr. Brown can increase his annual net income by approximately two thousand dollars with the addition of a semi-drylot enterprise of 137 cows. In the alternative case under the assumption that no straw can be purchased, he would be able to increase his income by almost twelve hundred dollars with 113 cows. Recalling that Mr. Brown's present net farm income is around ten thousand dollars, the computed change in income represents an increase of twenty percent or twelve and one-quarter percent respectively.

The important feature of this proposal is that no significant changes in current cropping practices or equipment would be required. This feature is the result of using grain and side products of grain as the only feeds. It has been mentioned several times in the text, however, that the exact effect is subject to variations of some of the components, such as prices.

It is beyond the scope of this study to analyze the possibility of a cow-calf enterprise without reducing cash grain production. Nevertheless, some remarks regarding this alternative will be useful. As mentioned in Chapter Four, approximately twenty cows are already kept on the farm. These are mainly supported, as a supplementary enterprise, by wild pasture and grain by-products. Those resources are not, however, fully utilized. If the farmer used all available straw (allowing for protection against erosion)

and chaff as feeds, he would be able to enlarge his present herd, even if no change were made in current crop production.

Before the farmer made a final decision, it would almost be necessary to estimate the income effects of other major alternatives, such as oilseed crop production, hog production, or another beef enterprise (feeder cattle, for example). The enterprise with the highest profitability could be chosen, although a farmer's personal preferences are also important.

Application of the method used in this case study can be used for other farm operators who wish to appraise profit possibilities of adding a cow-calf enterprise. However, it should be pointed out that each farm is unique in quantity and quality of resources which may be in surplus and thus available for such an enterprise. Therefore, generalized recommendations cannot be made for other farmers based on results for this particular operator. On the other hand, many grain farmers in the area do have unutilized pasture, coulees and sloughs, as well as idle winter labor which might make a cow-calf operation a feasible alternative.

Another benefit of the cow-calf enterprise on a wheat farm which should not be underestimated is the decrease in the uncertainty associated with a specialized grain farm. Although it is difficult to measure this benefit, it should be taken into account, even if the increase in average net income is slight. By keeping a larger herd of cows for calf production on the farm, variable yearly incomes from grain production can be offset by revenues from the cow-calf operation. A farmer may be prepared to sacrifice some profit for security and stable flows of income. From this point of view, the cow-calf enterprise has an insurance value. The fact that the cow-calf enterprise offers approximately ten extra dollars per day could be quite important if a farm faces a cash problem.

6.3. Suggestions for Further Research

The following topics are suggested for further study:

- 1) Effects of the cow-calf enterprise on net farm income using other feeds, namely industrial protein supplements rather than grain.
- 2) The possibility of feeding out calves on the farm as a feeder cattle enterprise.
- 3) The effects of aggregation of results from this typical farm over the census division, the province, or the Prairies.

BIBLIOGRAPHY

BIBLIOGRAPHY

- ALBERTA DEPARTMENT OF AGRICULTURE, 1969. "Beef Cow Shortage." Farm Notes, October 17.
- BAUER, L., 1967. 1966 Alberta Farm Business Report. Edmonton: Alberta Department of Agriculture.
- BENEKE, R.R., 1955. Managing the Farm Business. New York: John Wiley & Sons, Inc.
- CAMPBELL, H.G., 1965. An Introduction to Matrix Vectors and Linear Programming. New York: Appleton-Century-Crofts.
- CANADA DEPARTMENT OF AGRICULTURE, 1960-70. Livestock and Meat Trade Report. Ottawa: Markets Information Section, Production and Marketing Branch, CDA.
- CANADA DEPARTMENT OF AGRICULTURE, 1966. Soil Erosion by Wind: Cause, Damage, Control. Publication 1266. Ottawa: Queen's Printer.
- CANADA DOMINION BUREAU OF STATISTICS, 1968. 1966 Census of Canada, Agriculture, Alberta. Ottawa: Queen's Printer.
- CASTLE, E.N. and M.H. Becker, 1968. Farm Business Management. 8th ed. New York: John Wiley & Sons, Inc.
- CATTLEMEN, 1969a. "Cattle Ranch in Wheat Country." November, p. 12.
- CATTLEMEN, 1969b. "More Cattle No Cure for Grain Surplus." November, p. 36.
- CATTLEMEN, 1970. "Acre-and-a-Half to Wean a Calf." October, p. 19.
- DACIW, M., 1959. A Budgetary Analysis of Large Scale Milk Production. Bulletin 2. Winnipeg: University of Manitoba, Department of Agricultural Economics and Farm Management, July.
- DILLON, J.L., 1968. The Analysis of Response in Crop and Livestock Production. Toronto: Pergamon Press.

- DOLL, J.P., V.J. Rhodes, and J.G. West, 1969. Economics of Agricultural Production, Markets and Policy. Homewood, Illinois: Richard D. Irvin, Inc.
- DORFMAN, R., P.A. Samuelson, and R.M. Solow, 1958. Linear Programming and Economic Analysis. Toronto: McGraw-Hill Book Company, Inc.
- DULL, S., 1971. "Trouble in the Wind." The Furrow, June, p. 2.
- FAULKNER, C., 1970. "Drylot for Beef Cows." Country Guide, May, p. 10.
- FELLOWS, I.F., 1960. Budgeting: Tool of Research and Extension in Agricultural Economics. Bulletin 357. Storrs, Connecticut: University of Connecticut, Agricultural Experiment Station, August.
- FERGUSON, C.E., 1969. Microeconomic Theory. Rev. ed. Homewood, Illinois: Richard D. Irwin, Inc.
- GASS, S.I., 1964. Linear Programming. 2nd ed. Toronto: McGraw-Hill Book Company, Inc.
- GERSTNER, J., 1970. "Some Researchers Believe There's More Room for Expanding Cow-Calf Herds in the East than the West." The Furrow, March, p. 3.
- GILSON, J.C., 1960. Economic Aspects of Alternative Crop Rotation and Beef Production Systems: An Application of Linear Programming. Technical Bulletin 3. Winnipeg: University of Manitoba, Faculty of Agriculture and Home Economics.
- HEADY, E.O., 1964. Economics of Agricultural Production and Resource Use. 5th ed. Englewood Cliffs, New Jersey: Prentice-Hall, Inc.
- HEADY, E.O. and W. Candler, 1963. Linear Programming Methods. 3rd ed. Ames, Iowa: Iowa State University Press.
- HEADY, E.O. and J.L. Dillon, 1961. Agricultural Production Functions. Ames, Iowa: Iowa State University Press.

- HEADY, E.O. and H.R. Jensen, 1964. Farm Management Economics. 7th ed.
Englewood Cliffs, New Jersey: Prentice-Hall, Inc.
- HOPKINS, J.A. and E.O. Heady, 1962. Farm Records and Accounting. 5th ed.
Ames, Iowa: Iowa State University Press.
- KORDA, B., 1962. Ucebnice Linearniho Programovani. Praha: Statni
Nakladatelstvi Technicke Literatury.
- LANCASTER, K., 1969. Introduction to Modern Microeconomics. Chicago: Rand
McNally & Company.
- LAUGHLIN, R.E. and J.P. Doll, 1965. An Economic Analysis of Alternative
Beef Cattle Systems for a Large Farm in Central Missouri. Research
Bulletin 895. Columbia, Missouri: University of Missouri, College
of Agriculture, Agricultural Experiment Station, September.
- MADILL, J.W. 1969. "Crops: Situation, Outlook and Projections" in Direction
1970: Food Marketing Potential and Adjustments. Edmonton: Alberta
Department of Agriculture.
- NATIONAL ACADEMY OF SCIENCES, 1970. Nutrient Requirements of Beef Cattle.
4th rev. ed. Washington, D.C.
- NEUMANN, A.L. and R.R. Snapp, 1969. Beef Cattle. 6th ed. Toronto: John
Wiley & Sons, Inc.
- NORTH WEST FEEDS COMPANY, 1971. Suggested Retail Price List, F.O.B. Edmonton,
Alberta, April 26.
- PAUL, A.H., 1969. "An Analysis of Surface Hailfall Reports in Southern
Alberta." The Alberta Geographer, 5, p. 44.
- PETERSEN, T.A., 1971. "Analysis of Thirteen Years of Commercial Hail Sup-
pression in Central Alberta." Unpublished Ph.D. thesis, University
of Washington, Department of Agricultural Economics, Pullman,
Washington.

- RICHMOND, S.B., 1964. Statistical Analysis. 2nd ed. New York: The Ronald Press.
- ROSARIO, J.A., 1971. Prediction of Canadian Exports for Various Agricultural Commodities. Research in progress, Department of Agricultural Economics and Rural Sociology, University of Alberta, Edmonton, Alberta.
- ROY, J.H.B., 1970a. The Calf, Management and Feeding. University Park, Pennsylvania: Pennsylvania State University Press.
- ROY, J.H.B., 1970b. The Calf, Nutrition and Health. University Press, Pennsylvania: Pennsylvania State University Press.
- SINGH, I.D. and N.C. Stoskopf, 1971. "Harvest Index in Cereals." Agronomy Journal, 63, March-April, pp. 224-226.
- SPIEGEL, M.R., 1961. Theory and Problems of Statistics. New York: Schaum Publishing Company.
- UNITED GRAIN GROWERS, 1970. "Cow-Calf Production in a Drylot." The Grain Grower, April, p. 420.416.
- UNITED GRAIN GROWERS, 1971. "Year-Round Management Calendar for Cow-Calf Operations." The Grain Grower, April, p. 400.724.
- WINTER, G.R., 1969. "Some Positive Suggestions for the Wheat Economy." Paper presented to the Department of Agricultural Economics and Rural Sociology, University of Alberta, Edmonton, October 20. (Mimeographed.)
- YANKOWSKY, Z.J., 1970. "The Intermediate and Long Term Market Outlook for Canadian Beef." Canadian Journal of Agricultural Economics, June, pp. 53-70.

APPENDICES

APPENDIX A

MATHEMATICAL EXPANSION OF ECONOMIC THEORY DISCUSSED IN CHAPTER 2

2.1.1 Input-Output Model

There are three conditions for long run profit maximization:

(1)

Defining $TR = Y \cdot P$

$$TC = X \cdot R$$

the condition is $TR \geq TC$

(2) a) Factor approach:

Defining $MPP = \frac{dY}{dX}$

$$MVP = MPP \cdot P = \frac{dY}{dX} \cdot P$$

$$MFC = \frac{dTC}{dX} = \frac{dXR}{dX} = R$$

then for profit maximization

$$MVP = MFC = R$$

or $MPP \cdot P = R$

or $\frac{dY}{dX} \cdot P = R$

or $\frac{dY}{dX} = \frac{R}{P}$

b) Product approach:

Defining $MR = \frac{dTR}{dY} = \frac{dYP}{dY} = P$

$$MC = \frac{dTC}{dY} = \frac{dXR}{dY}$$

$$\Pi = TR - TC$$

then for profit maximization

$$\frac{d\Pi}{dY} = 0$$

$$\frac{dTR - dTC}{dY} = 0$$

$$MR - MC = 0$$

$$MR = MC$$

$$P = \frac{dXR}{dY}$$

$$\frac{P}{R} = \frac{dX}{dY}$$

or

$$\frac{dY}{dX} = \frac{R}{P}$$

(3)

The condition

$$\frac{d^2\Pi}{d^2Y} < 0$$

ensures a convex shape of profit function.

2.1.2 Input-Input Model

Let

$$Y = f(X_1, X_2)$$

and

$$MRS_{2,1} = \frac{dX_1}{dX_2}$$

for the least-cost combination

$$MC_1 = MC_2$$

or

$$\frac{dX_1 R_1}{dY} = \frac{dX_2 R_2}{dY}$$

$$dX_1 R_1 = dX_2 R_2$$

$$\frac{dX_1}{dX_2} = \frac{R_2}{R_1}$$

then

$$MRS_{2,1} = \frac{R_2}{R_1}$$

or

$$\frac{R_1}{MPP_1} = \frac{R_2}{MPP_2}$$

therefore

$$\frac{R_1}{R_2} = \frac{MPP_1}{MPP_2}$$

2.1.3 Output-Output Model

Let $(Y_1, Y_2) = f(X)$

and $MRT_{2,1} = \frac{dY_1}{dY_2}$

for the maximum revenue combination

$$MVP_1 = MVP_2$$

or $\frac{dY_1 P_1}{dX} = \frac{dY_2 P_2}{dX}$

$$dY_1 P_1 = dY_2 P_2$$

$$\frac{dY_1}{dY_2} = \frac{P_2}{P_1}$$

then $MRT_{2,1} = \frac{P_2}{P_1}$

or $MPP_1 \cdot P_1 = MPP_2 \cdot P_2$

therefore $\frac{P_1}{P_2} = \frac{MPP_2}{MPP_1}$

Where:

Y is product

X is factor

P is price of product

R is price of factor

Π is profit

TR is total revenue

TC is total cost

MR is marginal revenue

MC is marginal cost

MFC is marginal factor cost

MPP is marginal physical product

MVP is marginal value product

$MRS_{2,1}$ is marginal rate of substitution of factor two for factor one

$MRT_{2,1}$ is marginal rate of transformation of product two for product one

APPENDIX B

THE SEMI-DRYLOT APPROACH AS A METHOD OF BEEF CALF PRODUCTION

Most of the well-known systems of beef production, such as purebred, feeder calf, stocker, baby beef, finished cattle or dual-purpose production, can be carried out by one of two methods: ranching with extensive grazing operations, on the one hand, and keeping the cattle in confinement on drylots, on the other. The fundamental difference between these two approaches is the method of feeding. In pure ranching, native grass is the only feed with pasturing as a feeding method; the drylot approach often uses more than one kind of feed, and the feed has to be transported to the animals. Both methods have their own advantages and disadvantages.

Among the advantages of pure ranching are the low cost of feed, natural living conditions for the animals, low variable costs other than feed, low fixed costs, little labor use, and little care. Disadvantages usually include lower levels of production, higher animal mortality, low control possibilities (for example, disease control), and loss of nutrients, especially energy, due to more travel by the animals in the grazing process.

The drylot system, on the other hand, has the opposite features. High fixed and variable costs, necessitated by the higher level of management required, and some potential health hazards caused by limitation of natural conditions for the animals constitute the disadvantages. There are, however, a number of advantages, such as higher animal productivity, greater control possibilities, and a decrease in nutrient losses.

A method which includes some elements of both these extremes can be called either semi-drylot or semi-ranching. The first term, however, refers to a method arising from an adaptation of the pure drylot. The important

element distinguishing semi-drylot from drylot is the existence of some pasture. Three types of pasture are possible: (a) temporary total pasture, (b) permanent partial pasture, and (c) temporary partial pasture.¹ The semi-drylot method is especially applicable in a situation where there is a piece of wild pasture or coulee which has no alternative use because of the quality or the topography of the land.

Under good management the semi-drylot approach could compensate for certain disadvantages of the pure drylot method. It can decrease feed costs to some extent by utilizing grazing land which has no other alternative opportunity value. It can also decrease operating costs by eliminating the cleaning of lots. Reduction of health problems by provision of natural conditions for livestock is another added advantages of the semi-drylot method. On the other hand, good management should ensure retention of all the advantages of the pure drylot method. If the pasture is close to the farm residence, good control of the animals can be maintained. An organized system of semi-drylot pastures will also ensure that cattle do not lose weight through excessive movement.

Detailed technological practices in the semi-drylot method for beef calf production will depend on specific conditions. For Mr. Brown's farm, the following yearly schedule of feeding practices and other activities of the cow-calf operation is suggested:

¹The term "partial" refers to "as a part of feed ration." Pasture in this context includes not only greenfeed pasture but also aftermath.

Month	Feed source	Other beef enterprise activities
January:	feeding ¹	
February:		
March:		- calving
April:	grazing aftermath from last year's crop, grass from fence lines, sloughs, etc.	
May:		
June:		- breeding
July:	grazing available wild pasture plus additional feeding	- selling cull cows, branding, vaccination, castration
August:		
September:		
October:		
November:	grazing crop aftermath, chaff piles, plus additional feeding	- selling calves
December:		

¹The term "feeding" is reserved for transported supply of feeds from the field or the farm to the confined feeding area or feedlot.

APPENDIX C

COMPOSITION OF HERD MANAGEMENT UNITS

Table C.1

THE COMPOSITION OF 100 HERD MANAGEMENT UNITS

Category of Cattle	Treated as ¹	Number of head ²	Number of feed days per year ²
Mature cow—dry, pregnant	Dry Pregnant Mat.Cow; 500 kg	85	240
Heifer—dry, pregnant	Dry Pregnant Mat.Cow; 400 kg	15	240
Mature cow—nursing	Cow Nurs.Calf 3-4 mo.; 500 kg	85	125
Heifer—nursing	Cow Nurs.Calf 3-4 mo.; 400 kg	15	125
Young heifer	Growing Heif.; 300 kg; 0.5 kg gain	15	240
Calf—steer	Growing Steer; 150 kg; 0.5 kg gain	45	125
Calf—heifer	Growing Heif.; 150 kg; 0.5 kg gain	45	125

¹According to classification in Nutrient Tables [NATIONAL ACADEMY OF SCIENCES, 1970].

²Requirement of a single nutrient per animal per day has been multiplied by number of head and number of days in order to obtain annual requirement for a category of animals. Summation for all categories gives the annual requirement of the single nutrient for a hundred herd management units.

Table C.2

THE COMPOSITION OF RESULTING NUMBERS OF HERD MANAGEMENT UNITS

Category of Cattle	Number of Head under: ¹	
	Program I	Program II
Herd Management Units	137	113
Mature breeding cows	116	96
Breeding heifers	21	17
Replacement heifers	21	17
Steer calves	62	51
Heifer calves	62	51

¹Rounded to the closest whole number.

APPENDIX D

LIST OF MACHINERY WITH PRESENT MARKET VALUES AS OF
MID-1970 ON MR. BROWN'S FARM

1 car	\$ 1,500
1 large truck	\$ 1,000
1 small truck	\$ 800
1 large tractor	\$ 6,000
1 small tractor	\$ 600
1 combine	\$ 4,000
1 swather	\$ 300
1 discer	\$ 700
1 deep tillage cultivator	\$ 600
1 rod weeder	\$ 300
1 harrow	\$ 100
1 weed sprayer	\$ 200
2 grain loaders	\$ 500
1 baler	\$ 250
2 wagons	\$ 100
1 manure spreader	\$ 200
Miscellaneous farm tools	\$ 850
Total	<u>\$18,000</u>

84

